Base Realignment and Closure
Program Management Office West
San Diego, California

DRAFT FINAL
Parcel B Removal Site Evaluation Work Plan

Hunter's Point Naval Shipyard
San Francisco, California
~~December 2020~~May ~~July~~ 2021

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DCN: GLBN-0005-5364-0026

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Prepared for:

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Signature Quality Assurance Manager	Date
Signature Radiation Safety Officer	Date
Signature Project Manager	Date

Executive Summary

Background

Radiological surveys and remediation were previously conducted at former Hunters Point Naval Shipyard (HPNS) as part of a basewide Time-Critical Removal Action (TCRA). Tetra Tech EC, Inc. (TtEC), under contracts with the Department of the Navy (Navy), conducted a large portion of the basewide TCRA, including Parcel B. Data manipulation and falsification were committed by TtEC employees during the TCRA. An independent third-party evaluation of previous data identified additional potential manipulation, falsification, and data quality issues with data collected at Parcel B (Navy, 2017, 2018). As a result, the Navy developed this work plan to investigate radiological sites in Parcel B.

Project Purpose

The purpose of the investigation presented in this work plan is to determine whether current site conditions are compliant with the remedial action objective (RAO) in the *Amended Parcel B Record of Decision, Hunters Point Shipyard, San Francisco, California* (Project B ROD; Navy, 2009). The RAO for radiologically impacted soil and structures is to prevent receptor exposure to radionuclides of concern (ROCs) at concentrations that exceed remediation goals (RGs) for all potentially complete exposure pathways. ~~Additional reference background areas (RBAs) will also be identified to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Navy operations at HPNS. A statistical comparison of site data to applicable reference area data will be conducted.~~

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Scope

The radiological investigation will be conducted at the following sites within Parcel B:

- Former Sanitary Sewer and Storm Drain Trenches
- Building 103
- Building 113
- Building 113A
- Former Building 114
- Building 130
- Building 140
- Former Building 142
- Building 146
- Former Building 157

The sites and the locations of work are shown on **Table ES-1** and **Figure ES-1**.

Soil Investigations

Soil investigations will be conducted at the following areas:

- Former sanitary sewer and storm drain Trenches
- Former building sites and surface soil associated with existing buildings

Soil investigation areas will be divided into trench units (TUs) and surface soil survey units (SUs). The sizes and boundaries of the TUs and surface soil SUs will be based on the previous plans and reports.

Former Sanitary Sewer and Storm Drain Trench Units

For the TUs associated with former sanitary sewers and storm drains, a phased investigation approach was designed based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel B ROD RAO has been met for soil. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of TUs in Parcel B. Soil sampling at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel B ROD RAO. The Navy will re-excavate 100 percent of Phase 2 TUs if contamination is identified in Phase 1 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils.

Phase 1

Phase 1 includes the radiological investigation on a targeted group of TUs. Twenty-four of the 70 former sanitary sewer and storm drain TUs were selected for the Phase 1 investigation.

The radiological investigation of soil includes:

- Collection of systematic soil samples from each TU
- Gamma scan survey of 100 percent of the soil
- Collection of biased soil samples, where necessary, based on the gamma scan measurements

The targeted TUs were selected based on the highest potential for radiological contamination. The following information was used to select the units:

- Historical documentation of specific potential upstream sources, spills, or other indicators of potential contamination (see *Historical Radiological Assessment, Hunters Point Annex, Volume II, History of the Uses of General Radioactive Material 1939–2003* [HRA; Naval Sea Systems Command (NAVSEA), 2004])
- Signs of potential manipulation or falsification from the soil data evaluation

All of the soil (100 percent) will be excavated to the original TU boundaries, as practicable, and gamma scan surveys of the excavated material will be conducted. Excavated soil will be gamma scanned by laying it out on Radiological Screening Yard (RSY) pads for a surface scan. Following excavation to the original TU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex situ gamma scanning and sampling of the trench sidewalls and floors. The excavated soil from within each trench and the over-excavation will be tracked separately, and global positioning system (GPS) location-correlated results will be collected.

Systematic and biased samples will be collected from the excavated soil from the TUs and from the soil surrounding the TUs. A minimum of 18 systematic samples will be collected from each excavated soil unit and TU. The soil samples will be analyzed for the applicable ROCs by accredited off-site laboratories. Soil sample locations will be surveyed using GPS. If the investigation results from the gamma scan surveys and results from analysis of systematic and biased soil samples of the over-excavated material demonstrate exceedances of the RGs that are not attributed to naturally occurring radioactive material (NORM) or anthropogenic background, the material will be segregated for further evaluation. As directed by the Navy, an in situ investigation and/or remediation of the trench sidewalls and floor will be performed prior to backfill.

Phase 2
At the remaining 46 TUs, a gamma scan survey of 100 percent of accessible surface areas and soil sampling will be conducted. Subsurface soil samples will be collected via borings, with a minimum of 18 borings within the trench and one boring every 50 linear feet along the sidewalls of the trench. The borings will be advanced beyond the floor boundary of the trench or to the point of refusal. Gamma scans of the core will be conducted. Borehole locations will be surveyed using GPS. The soil samples will be analyzed for the applicable ROC analysis by accredited off-site laboratories.

Former Building Site and Existing Building Surface Soil Survey Units

At the 15 SUs associated with former building sites and existing building surface soil, the radiological investigation is based of surface soil on a proposal by the regulatory agencies and includes:

- Collection of a minimum of 18 systematic soil samples from each SU
- Gamma scan survey of 100 percent of the soil
- Collection of biased soil samples, where necessary, based on the gamma scan measurements

For all the surface soil SUs, gamma scan surveys of 100 percent of the surface soil will be conducted. GPS location-correlated results will be collected. Systematic and biased samples will be collected from the surface soil SUs. The soil samples will be analyzed for the applicable ROCs by accredited off-site laboratories. Soil sample locations will be surveyed using GPS.

Building Investigations

Investigations of interior surfaces will be performed for the following buildings:

- Building 103
- Building 113

- Building 113A
- Building 130
- Building 140
- Building 146

Buildings will be divided into SUs, and the sizes and boundaries of the SUs will be based on the previous plans and reports. The radiological investigation will be conducted to include:

- Collection of a minimum of 18 systematic static alpha-beta measurements from each SU
- Alpha and beta scan surfaces
- Collection of biased static alpha-beta measurements where necessary, based on the alpha-beta scan measurements
- Collection of swipe samples

Building 103 includes seven SUs consisting of exposed soil in the crawlspace that will be investigated the same as Phase 1 surface soil SUs.

For Building 140, data will be collected consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping, Hunters Point Shipyard, San Francisco, California* (TtEC, 2011) to confirm the conclusion of no further action.

Data Evaluation and Reporting

Data from the radiological investigation will be evaluated to determine whether the site conditions are compliant with the Parcel B ROD RAO. If the residual ROC concentrations are below the RGs in the Parcel B ROD (Navy, 2009) or are shown to be NORM or anthropogenic background, then the site conditions are compliant with the Parcel B ROD RAO. **Section 5.0** of this work plan provides additional information and details on data evaluation and reporting.

The following methods will be used to determine whether the residual ROC concentrations comply with the Parcel B ROD RAO:

- Each sample and static measurement result will be compared to the corresponding RG. If all residual ROC concentrations are less than or equal to the corresponding RG, then site conditions comply with the Parcel B ROD RAO.
- Sample and measurement data will be compared to appropriate RBA data and multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate (MLE) or background threshold value, graphical comparisons, and comparison with regional background levels. If all residual ROC concentrations are determined to be consistent with NORM or

anthropogenic background, then site conditions comply with the Parcel B ROD RAO.

- Each radium-226 (^{226}Ra) sample result exceeding both the corresponding RG and the expected range of background will be compared to concentrations of other radionuclides in the uranium natural decay series (see **Section 5.6**). If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel B ROD RAO.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a remedial action completion report (RACR) will be developed.

If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the RGs at the agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, then remediation will be conducted, followed by a RACR.

The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel B ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

Table ES-1: Soil Trench Units and Building Site Survey Units

Soil Investigations - Trench Units (TUs)		
Site	**Phase 1**	**Phase 2**
Former Sanitary Sewer and Storm Drain Trenches	TUs 4, 13, 21, 23, 26, 33, 36, 39, 45, 47-50, 50A, 51, 54, 56-57, 59, 65, 130-132, 186	TUs 1-3, 5-12, 14-20, 22, 24-25, 27-30, 37, 40-44, 46, 51A, 52-53, 55, 58, 60-64, 125-128
Soil Investigations - Surface Soil Survey Units (SUs)		
Building 103	SU A to SU G	
Former Building 114	SU-001 to SU-002	
Former Building 142	SU-001 to SU-003	
Former Building 157	SU-005 to SU-007	
Building Investigations		
Building 103	SU-001 to SU-014, SU-016 to SU-033	
Building 113	SU-001 to SU-033	
Building 113A	SU-001 to SU-016	
Building 130	SU 001 to SU-040	
Building 140	Data to be collected consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping* (TtEC, 2011)	

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Building 146	SU-001 to SU-007, SU-012 to SU-024, SU-030 to SU-042

Figure ES-1: Soil and Building Sites

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Acronyms and Abbreviations

^{60}Co	cobalt-60
^{90}Sr	strontium-90
^{90}Y	yttrium-90
^{99}Tc	technetium-99
^{137}Cs	cesium-137
^{210}Bi	bismuth-210
^{210}Pb	lead-210
^{210}Po	polonium-210
^{214}Bi	bismuth-214
^{214}Pb	lead-214
^{218}Po	polonium-218
^{222}Rn	radon-222
^{226}Ra	radium-226
~~^{228}Th~~	~~thorium-228~~
^{230}Th	thorium-230
~~^{232}Th~~	~~thorium-232~~
^{234}U	uranium-234
~~^{235}U~~	~~uranium-235~~
^{238}U	uranium-238
^{239}Pu	plutonium-239
Δ	shift
µCi/mL	microcurie(s) per milliliter
µR/hr	microroentgens per hour
σ	standard deviation
AHA	activity hazard analysis
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	below ground surface
BMP	best management practice
BRAC	Base Realignment and Closure

BTV	background threshold value
CCR	California Code of Regulations
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cm	centimeter(s)
cm^2	square centimeter(s)
cm/s	centimeter(s) per second
cpm	count(s) per minute
cpm/μR/hr	count(s) per minute per microroentgen per hour
cps	counts per second
CSM	conceptual site model
CSO	Caretaker Site Office
DAC	derived air concentration
dBA	decibels
dpm	disintegration(s) per minute
dpm/100 cm^2	disintegration(s) per minute per 100 square centimeters
DOT	Department of Transportation
DQA	data quality assessment
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
EM	Environmental Manager
ESU	excavation soil unit
Gilbane	Gilbane Federal
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
ID	identification
IL	investigation level
~~ISO~~	~~International Organization for Standardization~~
keV	kiloelectron volt
LBGR	lower boundary of the gray region
Levine-Fricke	Levine-Fricke Recon, Inc.

LLRW	low-level radioactive waste
m^2	square meter(s)
m^3	cubic meter(s)
m/s	meter(s) per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MLE	maximum likelihood estimate
MOU	memorandum of understanding
NA	not applicable
NaI	sodium iodide
NaI(Tl)	sodium iodide activated with thallium
NAVSEA	Naval Sea Systems Command
Navy	Department of the Navy
NORM	naturally occurring radioactive material
NRC	Nuclear Regulatory Commission
NRDL	Navy Radiological Defense Laboratory
NUREG	Nuclear Regulatory Commission Regulation
OSHA	Occupational Safety and Health Administration
pCi/g	picocurie(s) per gram
PPE	personal protective equipment
PRC	PRC Environmental Management
PRSO	Project Radiation Safety Officer
~~PSPC~~	~~position-sensitive proportional counter~~
QA	quality assurance
QC	quality control
RACR	remedial action completion report
RAO	remedial action objective
RASO	Radiological Affairs Support Office
RBA	reference background area
RCA	radiologically controlled area
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
rem	roentgen(s) equivalent man

RG	remediation goal
ROC	radionuclide of concern
ROD	record of decision
ROI	region of interest
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
~~RSCS~~	~~Radiation Safety and Control Services, Inc.~~
RSY	Radiological Screening Yard
RWP	Radiation Work Permit
SAP	Sampling and Analysis Plan
~~SCM~~	~~surface contamination monitor~~
SFU	sidewall floor unit
SIMS	Survey Information Management System
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SU	survey unit
SWPPP	Stormwater Pollution Prevention Plan
TCRA	time-critical removal action
TtEC	Tetra Tech EC, Inc.
TU	trench unit
UBGR	upper boundary of the gray region
USA North 811	Underground Service Alert of Northern/Central California and Nevada
USEPA	United States Environmental Protection Agency
VD	virtual detector
VOC	volatile organic compound
VSP	Visual Sample Plan

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1.0 Introduction

This work plan presents the tasks and procedures that will be implemented to investigate and evaluate radiologically impacted sites in Parcel B at former Hunters Point Naval Shipyard (HPNS), San Francisco, California (**Figure 1-1**). Radiological surveys and remediation were conducted previously at HPNS as part of a basewide Time-Critical Removal Action (TCRA). Tetra Tech EC, Inc. (TtEC), under contracts with the Department of the Navy (Navy), conducted a large portion of the basewide TCRA, including Parcel B. Data manipulation and falsification were committed by TtEC employees during the TCRA. An independent third-party evaluation of TtEC data identified evidence of manipulation, falsification, and data quality issues with data collected at Parcel B. As a result, the Navy will conduct investigations at radiologically impacted soil and building sites in Parcel B that were surveyed by TtEC (**Figure 1-2**).

The purpose of the investigation presented in this work plan is to determine whether site conditions are compliant with the remedial action objective (RAO) in the *Amended Parcel B Record of Decision, Hunters Point Shipyard, San Francisco, California* (Parcel B ROD; Navy, 2009). The RAO for radiologically impacted soil and structures is to prevent receptor exposure to radionuclides of concern (ROCs) at concentrations that exceed remediation goals (RGs) for all potentially complete exposure pathways. ~~Additional reference background areas (RBAs) will be identified to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Navy operations at HPNS. A statistical comparison of site data to applicable reference area data will be conducted.~~

The lead agency at HPNS is the Navy, and the lead federal regulatory agency is the United States Environmental Protection Agency (USEPA). The Navy will continue to work with USEPA and the State of California throughout the planning and site investigation process.

The approach for collection and evaluation of data is based on the Parcel B ROD (Navy, 2009) and this work plan. For soil, a phased approach, based on a proposal by the regulatory agencies, was designed to achieve a high level of confidence that ROD RGs have been met. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of trench units (TUs) associated with former sanitary sewers and storm drains in Parcel B. Soil sampling and gamma scan surveys at the remaining 67 percent of TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel B ROD RAO. The Navy will re-excavate 100% of Phase 2 TUs if contamination is identified in Phase 1 TUs. Because the survey design and implementation methods in this work plan are based on the regulators' proposal and their comments and compliance with the RGs in the Parcel B ROD (Navy, 2009), only applicable elements of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (USEPA et al., 2000) are incorporated.

The activities presented in this work plan will be conducted in accordance with this work plan, the sampling and analysis plan (SAP; **Appendix A**), and a separate accident prevention plan/site safety and health plan (APP/SSHP). Specific procedures to ensure data quality and worker safety are described in the SAP and APP/SSHP. Project requirements, including personnel roles and responsibilities, required training, and health and safety protocols are presented in **Section 6.0**, based on Gilbane Federal (Gilbane) leading and conducting the field activities.

2.0 Conceptual Site Model

This section provides an updated conceptual site model (CSM) (**Table 2-1**). The CSM summarizes the site description, history, and current status related to former sanitary sewers and storm drains and radiologically impacted buildings identified in the Historical Radiological Assessment (HRA; NAVSEA, 2004). The sanitary sewers and storm drains were once a combined system, and had been identified as radiologically impacted because of the possibility that radioactive waste materials were disposed of in sinks and drains, and the potential for the surrounding soil to be impacted by leakage and soil mixing during repairs. A removal action was initiated in 2006 to remove the sanitary sewers and storm drains. The removal action included excavation of overburden soil, removal of pipelines, plugging of open sanitary sewers and storm drains left in place during the removal process, ex situ radiological screening and sampling of the pipeline, and performance of final status surveys of the excavated soil and trench surfaces exposed by excavation. Soil was removed to a minimum of 1 foot below and to the sides of the sanitary sewer and storm drain piping.

Following the investigation and removal actions, there were allegations that TtEC potentially manipulated and falsely represented data, and some allegations have since been confirmed. In addition, the on-site laboratory used a screening method to analyze radium-226 (^{226}Ra) that may have reported at levels higher than actual radioactivity. TtEC presented CSMs in removal action completion reports that were based on potentially falsified data and screening results for ^{226}Ra reported by the on-site laboratory (results were biased high).

The results of additional investigation activities presented in this work plan will be used to update the CSM as needed.

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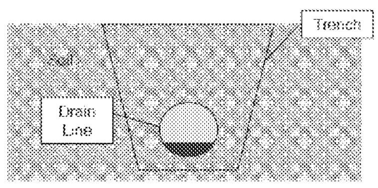
Table 2-1: Conceptual Site Model

Site Name		Former Hunters Point Naval Shipyard (Parcel B)
Site Location		Located on San Francisco Bay near the southeastern boundary of San Francisco, California. HPNS encompasses approximately 848 acres, including approximately 416 acres on land, at the point of a high, rocky, 2-mile-long peninsula projecting southeastward into San Francisco Bay. Parcel B occupies 59 acres in the northern portion of HPNS (**Figure 1-1**).
Site Operations and History		Navy Radiological Defense Laboratory (NRDL) activities associated with analyzing samples from nuclear weapons tests, scientific studies (fallout, plant, animal, materials), and production and use of calibration sources. The HRA also documents (in Table 5-1) that the Navy had five radioactive licenses with the Atomic Energy Commission for cesium-137 (^{137}Cs), one for a quantity of 3,000 curies and a separate quantity of 20 curies of ^{137}Cs. Two licenses indicate that ^{137}Cs was in sources. In some cases, the Navy made its own sources with ^{137}Cs. Use of radiography sources. Use and potential disposal of radiological commodities, including discrete devices removed from ships (e.g., deck markers, radium dials) and welding rods. Historical radiological material use documented in the HRA (NAVSEA, 2004) lists "impacted sites" – sites with potential for radioactive contamination. Former surface soil impacted by fallout may be subsurface soil today because of fill activities.
Historical Site Conditions		Portions of the facility were created from fill with some background levels of radionuclides (e.g., NORM and fallout). Dredge spoils from local berths were used as fill for some areas. Trenches were backfilled following removal of sewer lines. Trench backfill is mixed, but documentation of source is available (on-site fill, off-site fill, or mixture). Bay mud or bedrock marks the bottom extent of fill material. The site drainage system was designed in the 1940s to discharge to San Francisco Bay and was separated into sanitary sewers and storm drains in 1958, 1973, and 1976, but never completed.
Potential Source Areas	**Potential Historical Sources of Radiological Contamination**	Potential spills and releases from: Storage of samples from nuclear weapons tests at various NRDL facilities NRDL waste disposal operations Incidental disposal of radioluminescent commodities (e.g., dials, deck markers) during maintenance, individually or attached to equipment. Leaking radiography sources could affect buildings listed in HRA Table 6-1. Small amounts of liquid low-level radioactive waste (LLRW) were authorized for release with dilution to sanitary sewers based on regulations in place at the time.
	Release Areas in Parcel B (within work scope)	**Known Release Areas (from Section 6.4 of the HRA):** None **Potential Releases Identified after the HRA:** None
	Impacted Buildings in Parcel B (within work scope)	**Impacted Buildings with High Contamination Potential (from Table 8-2 of HRA):** None **Impacted Buildings with Moderate Contamination Potential (from Table 8-2 of HRA):** None **Impacted Buildings with Low or No Contamination Potential (from Table 8-2 of HRA):** Building 103 – Leased building built as a standard WWII wooden barracks; i.e., long, narrow rectangular building topped by a shallow gabled roof with narrow eaves. Building 103 was used as a submarine crew barracks and decontamination center for Operations Crossroads personnel. Building 113 – Three-story wood-framed shop building with a shallow gabled roof. Its former uses include tug maintenance, salvage diver facility, torpedo storage and overhaul, and storage of atomic weapons test samples. Building 113A – Concrete storage vault enclosed by a corrugated metal-sided shallow gable roof structure. It was formerly used as a torpedo storage building, non-destructive test facility, machine and maintenance shop, shipyard analytical laboratory, radioactive material/waste storage facility, and as a radiographer's vault. Building 114 – Demolished building that housed the NRDL design branch and technical library. Building 130 – Wood-framed shop building built in 1944 that includes open sheds on both sides and an almost flat, shallow gabled roof with wooden sliding industrial doors at either end. Building 130 currently is used for environmental hazardous material storage. Formerly it was used as an LLRW storage area, pipe fitter shop, ship repair shop, machine shop, and metal-working shop. Building 140 – Unoccupied one-story rectangular brick building with a rounded eastern end resembling an apse. Building 140 was used as a dry dock pump house and discharge channel. Building 142 – Demolished concrete building that was used as an air raid shelter, weapons test high-level sample storage area, and a low background sample counting room. Building 146 – Wood-framed structure with a shallow gable roof with windows built in 1945. Its former uses included industrial and photo laboratory, general shops, radioactive waste storage area, and radioluminescent device turn-in building. Building 157 – Demolished corrugated metal, wood-framed structure. Building 157 was used as a shipyard industrial laboratory, non-destructive testing and sound laboratory, metals testing shop, and metal shop. **Buildings Identified after the HRA:** None
Radionuclides of Concern for Parcel B (from Table 8-2 of HRA)[1]		^{226}Ra (Buildings 103, 113A, 114, 130, 140, 142, 146, 157) ^{137}Cs (Buildings 103, 113, 113A, 114, 130, 140, 142, 146, 157) Strontium-90 (^{90}Sr; Buildings 103, 113, 114, 140, 142, 146) Cobalt-60 (^{60}Co; Building 157)[2] Plutonium-239 (^{239}Pu; Buildings 103, 113, 140, 142)

[1] The site-specific ROCs for the soil and building investigations are listed in **Table 3-4** and **Table 4-1**.

[2] The most recent documented use of Building 157 as an industrial laboratory was 1984 (**HRA Table 3-4**); therefore, any residual ^{60}Co (half-life = 5.26 years) has undergone decay of nearly seven half-lives.

Table 2-1: Conceptual Site Model

Potential Migration Pathways	Releases to soil and air.
	Releases to sanitary sewer lines.
	  Buildings with known releases
	Releases to storm drains.
	  Incomplete separation from sanitary sewer lines
	Runoff from surface spills.
	Releases from potentially leaking storm drain and sanitary sewer lines to surrounding soil (lines and soil now removed).
	
	
	Conceptual Cross Section of Drain Lines
	Release of sediments from breaks or seams during power washing of drain lines.

Potential Exposure Pathways	Soil:
	  External radiation from ROCs
	  Incidental ingestion and inhalation of soil and dust with ROCs for intrusive activities disturbing soil beneath the durable cover (only construction worker receptor)
	Building surfaces:
	  External radiation from ROCs
	  Inhalation and incidental ingestion of re-suspended radionuclides

Current Status	HPNS is not an active military installation. In 1991, HPNS was selected for closure pursuant to the terms of the Defense Base Realignment and Closure (BRAC) Act of 1990. For more than 20 years, the Navy leased many HPNS buildings to private tenants and Navy-related entities for industrial and artistic uses. Current leases include art studios and a police department facility. Parcels A, D-2, UC-1, and UC-2 have been transferred to the City and County of San Francisco for non-defense use, and transfer of the remaining areas of HPNS also is planned.
	All known sources removed by Navy using standards at the time.
	  Follow-up investigations resulted in removal of small volumes of soil to meet current RGs
	Sanitary sewer and storm drain removal investigation conducted at Parcel B from 2006 to 2010.
	  More than 4.7 miles of trench lines and 65,000 cubic yards of soil investigated and disposed of or cleared for use as on-site fill
	  Trench excavations that have been backfilled now contain homogenized soil from on-site fill, off-site fill, or a mixture of both

Uncertainties	Lower potential for radiological contamination than originally described in historical CSMs based on the following lines of evidence:
	  Known sources have been removed.
	  Sanitary sewers and storm drains, and 1 foot of soil surrounding the pipe removed. The sewer lines were removed to within 10 feet of all buildings. Impacted buildings had remaining lines removed during surveys of the buildings. Non-impacted buildings had surveys performed at ends of pipes, and pipes were capped.
	  Any residual concentrations may be modified by radiological decay (shorter-lived radionuclides, such as ^{137}Cs and ^{90}Sr) or remobilization (including weathering and migration).
	  Sediment data from inside pipe not indicative of a large quantity disposal or contamination.
	  Overestimation of ^{226}Ra concentrations in soil by the on-site laboratory using an imprecise measurement method.
	Data manipulation or falsification.
	Data quality deficiencies.
	^{137}Cs and ^{90}Sr are present at HPNS because of global fallout from nuclear testing or accidents, in addition to being potentially present as a result of Navy activities. Because of backfill activities, ^{137}Cs and ^{90}Sr from fallout and Navy activities are not necessarily only on the surface and may be present in both surface and subsurface soil.
	Potential for isolated radiological commodities randomly distributed around the site.
	Trenches where gamma scan data exceeded the investigation level (IL) and biased soil samples were not collected.

Notes:

^{60}Co = cobalt-60
^{90}Sr = strontium-90
^{137}Cs = cesium-137
^{239}Pu = plutonium-239
BRAC = Base Realignment and Closure
IL = investigation level
LLRW = low-level radioactive waste
NORM = naturally occurring radioactive material
NRDL = Navy Radiological Defense Laboratory
pCi/g = picocurie(s) per gram

3.0 Soil Investigation Design and Implementation

This section describes the data quality objectives (DQOs), ROCs, RGs, investigation levels (ILs), and radiological investigation design and implementation for Parcel B soil.

3.1 Data Quality Objectives

The DQOs for the soil investigation are as follows:

- **Step 1-State the Problem**: Data manipulation and falsification were committed by a contractor during past sanitary sewer and storm drain removal actions and current and former building investigations for soil. The Technical Team evaluated soil data and found evidence of potential manipulation and falsification. The findings call into question the reliability of soil data and there is uncertainty whether radiological contamination was present or remains in place. Therefore, the property cannot be transferred as planned. Based on the uncertainty and the description of radiological activities in the HRA, there is a potential for residual radioactivity to be present in soil.
- **Step 2-Identify the Objective**: The primary objective is to determine whether site conditions are compliant with the Parcel B ROD RAO (Navy, 2009).
- **Step 3-Identify Inputs to the Objective**: The inputs include surface soil and subsurface soil analytical data for the applicable ROCs and gamma scan measurements to identify biased soil sample locations. RBA surface and subsurface soil analytical data for ROCs will also be used to confirm, or update as necessary, estimates of naturally occurring and man-made background levels for ROCs not attributed to Navy operations at HPNS.
- **Step 4-Define the Study Boundaries**: See Phase 1 and Phase 2 TUs and surface soil survey units (SUs) listed in **Tables 3-1 through 3-3** and shown on **Figure 3-1**.
- **Step 5-Develop Decision Rules:**
  - If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a remedial action completion report (RACR) will be developed.
  - If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted followed by preparation of a RACR. Remediation will be based on the following:
    - If one Phase 1 TU does not meet the Parcel B ROD RAO, all Phase 2 TUs will be excavated.

> If all Phase 1 TUs meet the Parcel B ROD RAO, Phase 2 will be initiated for TUs.

> If any one surface soil TU or Phase 2 TU does not meet the Parcel B ROD RAO, the TU will be excavated.

- The RACR will describe the results of the investigation, explain any remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel B ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

- **Step 6-Specify the Performance Criteria:** The data evaluation process for demonstrating compliance with the Parcel B ROD RAO is presented in **Section 5.0** and depicted on **Figure 3-2**.
  - Compare each ROC concentration for every sample to the corresponding RG presented in **Section 3.3**.

    > If all concentrations for all ROCs for all samples are less than or equal to the RGs, then compliance with the Parcel B ROD RAO is achieved.

  - Compare sample data to appropriate RBA data from HPNS as described in **Section 5.0**. Multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of a maximum likelihood estimate (MLE) or background threshold value (BTV), graphical comparisons, and comparison with regional background levels.

    > If all residual ROC concentrations are consistent with NORM or anthropogenic background, site conditions comply with the Parcel B ROD RAO.

    > If any ^{226}Ra gamma spectroscopy concentration exceeds the ^{226}Ra RG and the range of expected NORM concentrations, then the soil sample will be analyzed using alpha spectroscopy for uranium isotopes (specifically uranium-238 [^{238}U]~~, uranium-235 [^{235}U],~~ and uranium-234 [^{234}U]), thorium isotopes (~~thorium-232 [^{232}Th],~~ specifically thorium-230 [^{230}Th]~~, and thorium-228 [^{228}Th]~~), and ^{226}Ra to evaluate equilibrium conditions. If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel B ROD RAO.

  - If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be performed prior to backfilling.

- **Step 7-Develop the Plan for Obtaining Data:**
  - Phase 1 TUs – The radiological investigation will be conducted on a targeted group of 24 of the 70 TUs associated with former sanitary sewers and storm drains in Parcel B (see **Figure 3-1**). For Phase 1 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils. Soil will be excavated to the original TU boundaries, as practicable. Following excavation to the original TU boundaries, additional excavation of approximately 6 inches of the trench sidewalls and floors will be performed to provide ex-situ gamma scanning and sampling of the trench sidewalls and floors. Excavated soil will be 100 percent gamma scanned by laying it out on Radiological Screening Yard (RSY) pads. Systematic and biased samples will be collected from the excavated soil for off-site analysis.
  - Phase 2 TUs – Additional gamma scan surveys and soil sampling will be conducted on the remaining 46 TUs associated with former sanitary sewers and storm drains in Parcel B (see **Figure 3-1**). Each Phase 2 TU will undergo a gamma scan survey of 100 percent of accessible surface areas, along with soil sample collection via borings from soil within the former trench boundaries and from soil representing the former trench walls and floors, as practicable. Prior to the survey, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose the target soils. The borings will be advanced approximately 6 inches below the depth of previous excavation and will be gamma scanned upon retrieval. Phase 2 will only be performed if no contamination is found during Phase 1. If contamination is found during Phase 1, then all of the Phase 2 TUs will be excavated and investigated in a manner similar to the Phase 1 TUs.
  - Surface Soil SUs – The radiological investigation will be conducted at the 15 SUs associated with surface soil at Buildings 103 and former Buildings 114, 142, and 157 in Parcel B (see **Figure 3-1**). The SUs will be investigated by conducting a gamma scan survey of 100 percent of the surface soil, along with sample collection from systematic and biased locations for off-site analysis.
  - The soil samples collected will be analyzed for the applicable ROCs by accredited off-site laboratories and the results will be evaluated as described in Step 6. Global positioning system (GPS) location correlated results will be collected or surveying will be conducted.

3.2 Radionuclides of Concern

The ROCs for Parcel B soil are based on the HRA (NAVSEA, 2004) and Parcel B ROD (Navy, 2009) as presented in **Table 3-4**.

Table 3-4: Soil Radionuclides of Concern

Soil Area	Radionuclide of Concern
Former Sanitary Sewer and Storm Drain	^{137}Cs, ^{226}Ra, ^{90}Sr
Buildings 103, 114, 142, and 157	^{137}Cs, $^{60}Co^{a}$, ^{226}Ra, ^{90}Sr, ^{239}Pu

Notes:
[a] ^{60}Co is a ROC only for Building 157, whose most recent documented use as an industrial laboratory was 1984 (HRA Table 3-4); therefore, ^{60}Co (half-life = 5.26 years) has undergone decay of nearly seven half-lives.

3.3 Remediation Goals

The soil data from the radiological investigation will be evaluated to determine whether site conditions are compliant with the RAO in the Parcel B ROD (Navy, 2009). The RAO is to prevent exposure to ROCs at concentrations that exceed RGs for all potentially complete exposure pathways. The RG for each ROC is presented in **Table 3-5**. The soil data will be compared to the applicable RGs using a single sample comparison and evaluated as described in **Section 5.0**.

Table 3-5: Soil Remediation Goals from Parcel B ROD

Radionuclide	Residential Soil Remediation Goal[a] (pCi/g)
^{137}Cs	0.113
$^{60}Co^{b}$	0.0361
$^{239}Pu^{c}$	2.59
^{226}Ra	1.0[d]
^{90}Sr	0.331

Notes:
[a] All RGs will be applied as stated in the Parcel B ROD. Analytical results also will be compared to RGs or background values, whichever is higher.
[b] ^{60}Co is a ROC only for Building 157, whose most recent documented use as an industrial laboratory was 1984 (HRA Table 3-4); therefore, ^{60}Co (half-life = 5.26 years) has undergone decay of nearly seven half-lives.
[c] ^{239}Pu is a ROC only for Buildings 103, 140, and 142.
[d] The ^{226}Ra RG is 1 pCi/g above background.

3.3.1 Investigation Levels

ILs are media-specific or instrument-specific measurements that trigger a follow-up response, such as further investigation, if exceeded.

ILs are expressed in units of the instrument's response (such as counts per minute [cpm]) and are used to indicate when additional investigations (**Section 5.0**) are required. ILs are established for each instrument and vary with measurement type (e.g., scan, static). Scan measurements will be flagged when they exceed ILs.

For gamma scan surveys, measurements above the IL will prompt investigations that may result in the collection of biased samples or additional field measurements to determine the areal extent of the elevated activity. Potential causes of elevated gamma scan measurements may include discrete radioactive objects (e.g., deck markers), localized soil contamination, measurement geometry effects, and NORM. Ex situ gamma scan surveys will be performed using detector systems equipped with gamma spectroscopy to provide real-time radionuclide-specific measurements. The spectra will be evaluated using region of interest (ROI)-peak identification tools for the ROCs that correspond to gamma rays at 186 kiloelectron volts (keV) for ^{226}Ra, 609 keV for ^{226}Ra progeny bismuth-214 (^{214}Bi), 662 keV for ^{137}Cs, and other gamma emissions associated with the uranium and thorium decay series. The gamma scanning system will detect ^{137}Cs photons; however, individual measurements are not intended to characterize ^{137}Cs at or below the RG. In addition, gross gamma energy windows may be used to identify radiological anomalies that are not readily identified with a single gamma energy, such as the bremsstrahlung radiation from a deck marker containing ^{90}Sr.

~~The gamma spectroscopy detector system also may be used to assess gamma scan investigation locations using a 1-minute or greater static count and spectral analysis to compare the activity at a specific point to background.~~ For gamma scan investigations, the net spectrum will be plotted and the critical levels assessed for ROC-specific energy ranges to find out if there is any activity present above background. Critical levels, as defined in the MARSSIM Section 6.7.1, represent thresholds above which net counts are statistically greater than background. If the gamma spectroscopy detector system ~~static~~ scan measurements identify locations with elevated activity, biased samples will be collected; otherwise, the ~~static~~ count spectra will be provided in the data reports. The analysis of gamma scan data collected by the RS-700 mobile gamma-ray detection system and triggers for further investigation are described in **Section 3.5.1.1**. ILs for other field instrumentation are typically equal to an upper estimate of the instrument- and material-specific background, such as the mean plus three standard deviations. Appropriate instrument- and site-specific gamma scan ILs for site ROC and gross gamma (i.e., full-energy spectrum) measurements will be those deemed applicable by the *Memorandum to File Regarding Radiological Remediation Goals for the Removal Site Evaluation Workplan for Parcels B, C, D-1, D-2, E, G, UC-1, UC-2, UC-3* (Navy, 2021), which were derived as part of the HPNS Background Soil Study (CH2M Hill, 2020). See Section 3.4.3 for additional information."~~determined following mobilization.~~ **Section 3.5** describes the minimum gamma scan survey instrument requirements and the methodology to determine instrument gamma scan minimum detectable concentrations (MDCs) in soil.

3.4 Radiological Investigation Design

This section describes the design of the radiological investigation, including gamma scan surveys and soil sampling. The radiological investigation design is primarily based on methods, techniques, and instrument systems to demonstrate compliance with the Parcel B ROD RAO (Navy, 2009). The SAP (**Appendix A**) provides additional guidance on soil sampling, chain-of-custody, laboratory analysis, and quality assurance (QA)/quality control (QC) requirements.

There are two types of Parcel B soil investigations discussed in this section:

- Surface and subsurface soil associated with former sanitary sewer and storm drain lines (TUs)
- Surface soil associated with Building 103 and former Buildings 114, 142, and 157 (SUs)

A phased investigation approach is planned for surface and subsurface TU soil associated with former sanitary sewer and storm drain lines. Phase 1 includes the radiological investigation of 24 of 70 previously established TUs in Parcel B and Phase 2 includes the remaining 46 TUs in Parcel B. The approach is based on a proposal by the regulatory agencies to achieve a high level of confidence that the Parcel B ROD RAO has been met for soil. For Phase 1, 100 percent of soil will be re-excavated and characterized at 33 percent of the TUs in Parcel B. Soil sampling and gamma scanning at the remaining 67 percent of the TUs will be performed as part of Phase 2 to increase confidence that current site conditions comply with the Parcel B ROD RAO. The Navy will re-excavate 100% of Phase 2 TUs if contamination is identified in Phase 1 TUs. For both Phase 1 TUs and Phase 2 TUs, the durable cover (including asphalt, asphalt base course, concrete, gravel, debris, or obstacles) will be removed to expose target soils.

The radiological investigation of the 15 previously established surface soil SUs in Parcel B will consist of a gamma scan survey of 100 percent of accessible surface areas followed by soil sampling.

The principal features of the investigation protocol to be applied to the Parcel B TUs and surface soil SUs are discussed herein and include:

- Number of samples
- Locating samples
- Establishing radiological background
- TU design
- SU design

To the extent possible, manual data entries will be reduced or eliminated through the use of electronic data collection and transfer processes.

3.4.1 Number of Samples

Soil samples will be collected on a systematic sampling grid and/or from biased locations identified by the gamma scan surveys. The number of systematic soil samples collected will be based on the guidance described in MARSSIM Sections 5.5.2.2 and 5.5.2.5 using ^{226}Ra as the example basis for calculating the minimum sample frequency. Even if the MARSSIM-recommended or other statistical tests are not used to evaluate site data, these calculations will serve as a basis for determining the number of samples per SU to be collected. The number of biased samples will be determined based on results of gamma scan surveys, and a minimum of one biased sample will be collected in every TU and SU.

Additional biased soil samples will be collected from locations on each radiological screening yard (RSY) pad or SU that represent the region of interest (ROI) with highest z-score for each ROC. In total 10 ROIs have been established for radium and its progeny as well as other naturally occurring or anthropogenic gamma-emitting radionuclides that may be of interest for soil excavated from formal sanitary sewer, formal storm drain lines, formal buildings site, and building crawl space.

A minimum of 3 biased samples (or 4 biased samples when ^{232}Th is an ROC) will be collected in every TU and SU scanned using the RS-700. Biased samples will be collected from the location of the highest scan z-score location for each gamma-emitting ROC, as well as from the highest scan z-score location from ROI 10 (gross gamma). For ROCs that have multiple RS-700 ROIs (i.e. ^{226}Ra), the highest scan z-score among those ROIs will be selected for biased sampling. In addition, biased samples will also be collected if gamma static measurement identify elevated locations as described in Section 3.3.1. If the locations of the selected biased samples are co-located (for example, if the highest scan z-score location for ^{137}Cs and the highest scan z-score location for gross gamma are the same location), one biased sample will be collected per location, as appropriate.

MARSSIM Section 5.5.2.2 defines the method for calculating the number of soil samples when residual radioactivity is uniformly present throughout an SU. Therefore, determining the number of samples will be based on the following factors:

- RG for radioactivity in soil (upper boundary of the gray region [UBGR])
- Lower boundary of the gray region (LBGR)
- Estimate of variability (standard deviation [s]) in the reference area and the SUs
- Shift (D=UBGR-LBGR)
- Relative shift ([UBGR-LBGR]/s) (see **Equation 3-1**)
- Decision error rates for making a Type I or Type II decision error that the mean or median concentration exceeds the RG (determined via MARSSIM Table 5.2)

Each of the preceding factors is addressed in the following paragraphs. Example data are provided to assist in explaining the process for calculating the minimum sample frequency. Actual numbers of samples for SUs will be based on reference area data once they become available. The data quality assessment (DQA) of SU data will include a retrospective power curve (based on the MARSSIM Appendix I guidance) to demonstrate that a sufficient number of samples was collected to meet the project objectives.

The ^{226}Ra RG is defined as 1 pCi/g plus background. As a basis for the calculations, the background ^{226}Ra soil concentration is assumed to be 1 pCi/g.

MARSSIM defines a gray region as the range of values in which the consequences of decision error on whether the ^{226}Ra concentration is less than or exceeds the RG are relatively minor. The RG of 1 pCi/g of ^{226}Ra above background (1 pCi/g) was selected to represent the UBGR (2 pCi/g). The LBGR is the median concentration in the SU, and the retrospective power will be determined as soon as practical after the survey is completed. Given the absence of data prior to performing the investigation activities, MARSSIM Section 2.5.4 suggests arbitrarily selecting the LBGR as half the RG. Therefore, for this example, the LBGR = 0.5 pCi/g + 1 pCi/g = 1.5 pCi/g. Assuming the UBGR equals the RG, then D = 0.5 pCi/g for this example.

MARSSIM defines s as an estimate of the standard deviation of the measured values in the SU. Because SU data will not be available until the investigation activities are completed, MARSSIM recommends using the standard deviation of the RBA as an estimate of s. Given the absence of data prior to performing the investigation activities, an arbitrary value of 0.25 pCi/g has been selected as an estimate of s for this example.

The relative shift is calculated based on MARSSIM guidance (Section 5.5.2.2) as shown in the following equation:

Equation 3-1

$$\frac{\Delta}{\sigma} = \frac{(UBGR - LBGR)}{\sigma} = \frac{(RG - LBGR)}{\sigma} = \frac{(2.0 - 1.5)}{0.25} = 2.0$$

The minimum number of samples assumes the ^{226}Ra concentration in the SU exceeds the RG. Type I decision error is deciding that the ^{226}Ra concentration in the SU is less than the RG when it actually exceeds the RG. To minimize the potential for releasing soil with concentrations above the RG, the Type I decision error rate is set at 0.01. A Type II decision error is deciding that the ^{226}Ra concentration exceeds the RG when it is actually less than the RG. To protect against remediating soil with concentrations below the RG, the Type II decision error rate is set at 0.05.

MARSSIM Table 5.3 lists the minimum number of samples to be collected in each SU and RBA based on the relative shift and decision error rates. For a relative shift of 2, with a Type I decision error rate of 0.01 and Type II decision error rate of 0.05, MARSSIM Table 5.3 recommends a minimum of 18 samples in each SU and RBA. For example, for Phase 1, a minimum of 18 samples would be collected for every 152 cubic meters (m^3) of soil (calculation provided in **Section 3.4.4.2**).

The minimum number of samples per SU will be developed based on the variability observed in the RBA data. A retrospective power curve will be prepared to demonstrate that the number of samples from each SU was sufficient to meet the project objectives. If necessary, additional samples may be collected to comply with the project objectives.

3.4.2 Locating Samples

Systematic soil samples will be located using Visual Sample Plan (VSP) software (or equivalent). Each TU or SU will be mapped, such that, at a minimum, 18 systematic soil samples will be collected in each TU or SU. The systematic soil samples will be plotted using a random start ~~square~~ triangular grid using the VSP software (or equivalent) with GPS coordinates for each systematic sample.

3.4.3 Radiological Background

~~The RGs presented in Table 3-5 are incremental concentrations above background; therefore,~~ RBA samples and measurements ~~will be~~have been collected and evaluated to provide generally representative data sets estimating natural background and fallout levels of man-made radionuclides for the majority of soils at HPNS and presented in the Final Background Soil Study (CH2M Hill, 2020). The RBA characterization ~~will~~ incorporated three survey techniques: gamma scans, surface soil sampling, and subsurface soil sampling to support data evaluations. Background values for Reference Background Area 1, located in Parcel B, are found in Table 6-6 and of the Background Soil Study and discussed in Section 5.2.1 of the same document (CH2M Hill, 2020). These soil background values will be utilized as deemed applicable by the *Memorandum to File Regarding Radiological Remediation Goals for the Removal Site Evaluation Workplan for Parcels B, C, D-1, D-2, E, G, UC-1, UC-2, UC-3* (Navy, 2021).

3.4.4 Phase 1 Trench Unit Design

Radiological investigations will be conducted on a targeted group of 24 of the 70 TUs associated with former sanitary sewer and storm drain lines (**Figure 3-1**). The former TUs selected for Phase 1 investigation were based on their location adjacent to (downstream/upstream from) impacted buildings. The names, sizes, and boundaries of the TUs will be based on the previous plans and reports (**Table 3-1**).

The Phase 1 TUs will be re-excavated to the previous excavation limits by making reasonable attempts to ensure accuracy in relocating the former TU boundaries (see **Section 3.6.3**). The excavated soil material will be investigated by gamma scan surveys and systematic and biased soil sample collection following the RSY pad process (**Section 3.6.3.2**). Trench unit soils will be segregated from other trench unit materials throughout the excavating, drying (if necessary), handling, screening, and sampling process to avoid cross-contamination or dilution of contamination. If the investigation results from the gamma scan surveys and results from the analysis of systematic and biased soil samples demonstrate potential exceedances of the RGs and background, the material will be segregated for further evaluation as described in **Section 5.3**.

To address the Phase 1 radiological investigations of the former trench sidewalls and floors, a strategy to excavate the former trenches to the previous excavation limits, and to over-excavate at least an additional 6 inches outside the estimated previous boundaries of the sidewalls and bottoms of the TUs will be employed. The exhumed over-excavated material will represent the trench sidewalls and bottom and will be gamma scanned and sampled ex situ, to provide the following benefits:

- Significant improvement of the measurement quality for gamma scan surveys by controlling the measurement geometry.

  - Material thickness will not exceed ~~6~~9 inches, regardless of whether the material has been re-excavated or is the additional sidewall/floor material.
  - Use of large-volume sodium iodide (NaI) detectors with shielding.
  - Use of large-volume NaI detectors with spectroscopy.
- Reducing the potential safety risks associated with in situ trench sidewall and bottom gamma scanning and sampling.
- Reducing the water management required to de-water trenches to provide unsaturated material for investigation.
- Increasing assurance that all potentially impacted materials are investigated because of the inherent limitations of finding exact boundaries.

The over-excavated material (representing sidewalls and floors) will be investigated in the same fashion as the excavated soil: by gamma scan surveys and soil sample collection by the RSY pad process (**Section 3.6.3.2**). The over-excavated material representing trench sidewalls and floors will be maintained as separate volumes (e.g., piles) of soil from the original excavated soil. If the investigation results from the gamma scan surveys and results from the analysis of systematic and biased soil samples of the over-excavated material demonstrate exceedances of the RGs or background, whichever is higher, the material will be segregated for further evaluation. An investigation of the trench sidewalls and floor will be performed as described in **Section 5.3**. An example Phase 1 TU location is presented on **Figure 3-3**.

3.4.4.1 Nomenclature of Phase 1 Trench Units

The former TUs will be excavated and characterized in "batches" or soil units that will be given new unique identifiers at the time of excavation by the geologist or Radiological Control Technician (RCT). Excavated material representing the backfill material from former TUs will use the following nomenclature format:

AABB-ESU-NNNA

Where:
AA = facility (HP for Hunters Point will be used in this work plan)
BB = site location (PB for Parcel B will be used in this work plan)
ESU = excavation soil unit
NNN = former trench unit number
A = alpha-numeric digit of each soil unit (beginning with A, in sequential order)

For example, the third soil unit of backfill TU material excavated from the former TU 186 will be identified as follows:

HPPB-ESU-186C

In this example, "HPPB" identifies Hunters Point Parcel B, "ESU" identifies excavation soil unit, "NNN" identifies the soil unit as being excavated from the former Trench Unit

186, and "C" represents the third soil unit created from excavation of this former TU. Excavated material representing the sidewalls and bottoms of former TUs will use the following nomenclature format:

AABB-SFU-NNNA

Where:
AA = facility (HP for Hunters Point will be used in this work plan)
BB = site location (PB for Parcel B will be used in this work plan)
SFU = sidewall floor unit
NNN = former trench unit number
A = alpha-numeric digit of each soil unit (beginning with A, in sequential order)

For example, the first soil unit of sidewall and floor material excavated from the former TU 125 will be identified as follows:

HPPB-SFU-125A

In this example, "SFU" identifies sidewall floor unit, "NNN" identifies the soil unit as being excavated from the former Trench Unit 125, and "A" represents the first soil unit created from excavating this former trench unit.

3.4.4.2 Size of Phase 1 Trench Units

RSY pads are designed to be approximately 1,000 square meters (m^2). Using the assumption that material will be assayed in geometries yielding a soil column thickness of 6 inches, the volume of a soil unit of excavated material (either ESU or SFU) is calculated as:

$$1000m^2 \times 0.1524m\ (6\ inches) = 152m^3$$

Therefore, an individual ESU or SFU volume will not exceed 152 m^3. While the maximum soil column thickness is 9 inches, the ESU or SFU volume will be limited to 152 m^3. Converting from m^3 to tons of soil (a more commonly used unit), the maximum soil unit size of excavated material will not exceed:

$$152m^3 \times \frac{1.3yd^3}{m^3} \times \frac{2{,}200lbs\ soil}{yd^3} \times \frac{1ton}{2{,}000lbs} \approx 217\ tons\ soil$$

This calculation assumes 2,200 pounds of loose soil per cubic yard, actual field conditions may vary from this assumption. Each former TU will be excavated and managed in soil units (i.e., ESUs or SFUs) no larger than approximately 152 m^3 and individually stockpiled prior to radiological screening. Using a maximum size of 152 m^3, the estimated number of expected ESUs created during the excavation of backfill from former TUs is listed in **Table 3-1**. Similarly, using a maximum size of 152 m^3, the estimated number of expected SFUs created during the over-excavation of former TUs (representing sidewalls and floors) is listed in **Table 3-1**.

The actual sizes of individual ESUs and SFUs will be determined in the field, based on the actual final excavation limits and volumes of soil material excised from the former trenches.

3.4.5 Phase 2 Trench Unit Design

The Phase 2 TUs are listed in **Table 3-2** and depicted on **Figure 3-1**. Investigations of the Phase 2 TUs will consist of a combination of gamma scan surveys and soil samples.

Each Phase 2 TU will undergo 100 percent gamma scan of accessible surface areas using an appropriate instrument listed in **Section 3.5**. The instrument will be composed of a gamma scintillation detector equipped with a spectroscopy system that measures gross gamma counts along with radionuclide-specific measurements and is coupled to a data logger that logs the count rate data in conjunction with location. Gross gamma and gamma spectra obtained during the surface gamma scan surveys will be analyzed using region-of-interest peak identification tools for the ROCs. Areas with elevated activity will be noted on a survey map and flagged in the field for verification. Manual gamma scans using a handheld instrument may be performed to further delineate suspect areas in the TU. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results greater than the ILs (**Section 5.3.1**).

Within the backfill of each previous TU boundary, VSP software (or equivalent) will be used to determine the location of the systematic soil boring locations (as determined in **Section 3.4.1**). A stylized graphic of an example Phase 2 TU with 18 systematic boring locations placed using a ~~square~~ triangular grid is shown on **Figure 3-4**. Each location will be cored down to approximately 6 inches below the depth of previous excavation. Each retrieved core will be gamma scanned along the entire length of the core. Gamma scan measurement results of the retrieved core will be evaluated to investigate the potential for small areas of elevated activity in the fill material. A sample will be collected from the top 6 inches of material, and a second sample will be collected from the 6 inches of material just below the previous excavation depth. Additionally, a third sample will be collected from the core segment with the highest gamma scan reading that was already not sampled. At least three samples will be collected from each of the 18 borings, for a total of 54 samples per previous TU boundary. The anticipated number of subsurface soil samples is shown in **Table 3-2**; however, additional locations or samples may be required based on the evaluation following analysis of RBA data.

In addition, systematic cores will be placed every 50 linear feet on each trench sidewall in order to collect samples from locations representative of the trench sidewalls. The systematic boring locations will be located approximately 6 inches outside of the previous sidewall excavation limits and will extend 6 inches past the maximum previous excavation depth on both sidewalls in every trench. In the same fashion described in the previous paragraph, core sections will be retrieved, gamma scanned, and sampled such that at least three samples will be collected from each of the boring locations. The projected number of borings and soil samples obtained from sidewall material is presented in **Table 3-2**. The typical sample locations representing the TU sidewalls are shown on **Figure 3-4**. The subsurface soil sampling process is detailed in **Section [REF _Ref516571616 \r \h * MERGEFORMAT]**. The soil samples will be submitted to the off-site analytical laboratory for analysis according to the SAP (**Appendix A**).

3.4.6 Surface Soil Survey Unit Design

Radiological investigations will be conducted at the 15 surface soil SUs associated with Buildings 103 and former Buildings 114, 142, and 157 where gamma scanning and sampling was previously conducted (**Figure 3-1**). The names, sizes, and boundaries of the SUs will be based on the previous plans and reports (**Table 3-3**).

Each surface soil SU will undergo a gamma scan survey of 100 percent of accessible surface areas using an appropriate instrument (as listed in **Section 3.5**). The instrument will be composed of a gamma scintillation detector equipped with spectroscopy coupled to a data logger that logs the resultant data in conjunction with location. Gross gamma and gamma spectra obtained during the surface gamma scan surveys will be analyzed using ROI-peak identification tools for the ROCs. Areas with elevated activity will be noted on a survey map and flagged in the field for verification. Manual gamma scans using a handheld instrument may be performed to further delineate suspect areas in the SU. Biased samples will be collected from potential areas of elevated activity displaying gamma scan survey results greater than the IL (**Section 5.3.1**).

Following the completion of the gamma scan surveys, the SU area will be plotted using VSP software (or equivalent) to determine the location of systematic samples. A stylized graphic of an example SU with 18 systematic samples placed using a square grid is shown on **Figure 3-4**. The surface soil sample collection process is detailed in **Section [REF _Ref516571656 \r \h * MERGEFORMAT]**. The soil samples collected from each SU will be submitted to the off-site analytical laboratory for analysis according to the SAP (**Appendix A**).

3.5 Instrumentation

Radiation instruments have been selected to perform measurements in the field. Specifics related to radiological investigation implementation are provided in **Section 3.6**. The laboratory instruments used to analyze the soil samples and the associated standard operating procedures (SOPs) for calibration, maintenance, testing, inspection, and QA/QC are discussed in the SAP (**Appendix A**).

The following instrumentation information is included in this section:

- Soil gamma scanning instruments
- Instrument detection calculations
- Calibration

- Daily performance checks

Instruments that are expected to be used during fieldwork for activities other than soil gamma scan surveys are described in **Section 6.5**.

3.5.1 Soil Gamma Scanning Instruments

The gamma scanning survey instruments have been selected to provide a high degree of defensibility and based on their capability to measure and quantify gamma radiation and position using the best available technology. The primary gamma scanning instrument that will be used during Phase 1 TU gamma scan surveys of excavated trench soil (following the RSY pad process) and surface soil SUs will consist of NaI scintillation detectors equipped with automated data logging. The gamma scan survey system will be equipped with gamma spectroscopy capabilities, providing the benefit of collecting spectral measurements in addition to the gross gamma measurements. The spectra will be evaluated using ROI-peak identification tools for the ROCs that correspond to gamma rays at 186 keV for ^{226}Ra, 609 keV for ^{226}Ra progeny ^{214}Bi, 662 keV for ^{137}Cs, and a gross gamma window (i.e., full energy spectrum). Details on the evaluation of ROIs and gross gamma windows for the RS-700 system are provided in **Section 3.5.1.1**.

For gamma scan surveys conducted on the Phase 1 TU surfaces, in the RSY pads, and in the surface soil SUs, the gamma scanning instrument also will be equipped with a GPS sensor and software that is able to simultaneously log continuous radiation and position data. The gamma scan measurement will be coupled to the position measurement to allow for precise visualization of the data set. For gamma scan surveys of retrieved cores, a gamma instrument consisting of a NaI detector will be used for gamma scan surveys of retrieved cores. The instruments that are expected to be used during fieldwork are listed in **Table 3-6**.

Table 3-6: Gamma Survey Instruments

Meter Manufacturer and Model	Detector Manufacturer and Model	Detector Type	Use
Radiation Solutions, Inc RS-700	RSI RSX-1	4 x 4 x 16 inches 4-liter NaI(TI) detectors (2)	Ex situ RSY and surface soil gamma scan surveys
Ludlum 2221	Ludlum Model 44-20	3 inches x 3 inches NaI(TI) detector	Soil area gamma scan surveys, sample screening, soil core surveys

Notes:
Equivalent alternative instrumentation may be used following approval by the PRSO.
NaI(TI) = sodium iodide activated with thallium
PRSO = Project Radiation Safety Officer

3.5.1.1 RS-700 Gamma Scan Data Analysis

The data collected during the gamma scan using the RS-700 system will be ~~evaluated as follows. A tiered approach is used during data review for the RS-700 system data to identify areas requiring additional surveys and biased samples as described in the second stage of the gamma scan surveys. Ten ROIs have been established for radium and progeny as well as other naturally occurring or anthropogenic gamma-emitting radionuclides that may be of interest. Three virtual detectors (VDs) are set up in the analysis software (RadAssist). VD1 denotes both detectors summed, VD3 refers to the left detector, and VD4 refers to the right detector~~processed using numerical and graphical methods. The data will be plotted using ArcGIS to ensure adequate scan coverage. Typically, the overlap between passes is designed for 120-150% coverage. The data will be re-projected into a desired coordinate system and X Y points added to the data file. The data file will be exported to Microsoft Excel for further exploratory data analysis. A tractor speed histogram will be developed using the position-correlated data as a quality control check to verify the proper speed of the detector over the ground.

The data will be checked for errors as well as examined for potential outliers and other anomalous features. Descriptive statistics (e.g., range, median, mean, and standard deviation) will be used to assess the data set. The data will be graphed on a cumulative frequency diagram to test departure from normality and to reveal characteristics of the data distribution such as dissimilar populations and data set outliers that may not be apparent otherwise. Data appearing as a straight line indicate a normally distributed data population. Non-linear regions suggest dissimilar populations included within the larger population.

Contour maps will be created using the RS-700 data to aid in field investigations as well as to facilitate the selection of biased measurement locations. The mean and standard deviation of the data set will be calculated and used to develop color-coded contour maps based on sigma values (i.e., the number of standard deviations each measurement lies from the mean). The contouring process involved creating a regularly spaced grid and assigning values to every spot on the grid. Grid node values will be assigned using a weighted average based on the inverse square law, which describes how radiation levels drop off with distance from a source. Once the grid is complete, color-coded contours will be created from grid node values within the specified ranges of values. The contouring process tends to smooth over single data points with lower sigma values while accentuating clustered areas or single locations with higher sigma values. This is the desired effect which aids in the data analysis by focusing attention on those areas most likely to contain discrete radioactivity. Any area in excess of 3 sigma will be identified by coordinates and investigated by gamma scan using instrumentation other than the RS-700~~First, the data file is replayed in RadAssist and reviewed for elevated count rates in several relevant ROIs. Next, the count rates for several relevant ROIs are plotted in a time series and reviewed for additional peaks. The Z-scores are calculated for each location in all ROIs for VDs 1, 3, and 4. Local Z-scores are also calculated using a moving average to identify elevated count rates where the background is variable, for SUs that meet this criterion. Semi-local Z-scores are~~

~~calculated using the global average but with a moving average for the standard deviation to identify smaller areas of elevated count rates that may not be otherwise identified by the initial Z-score review, for SUs that meet this criterion. Any location with four or more ROIs having a Z-Score, local Z-score, or semi-local Z-score, respectively, greater than 3 (Z>3) is marked for follow-up. These three types of Z-scores are also plotted in a time series and reviewed for additional peaks in Z-score. Finally, count rate ratios are calculated for key ROIs and reviewed for obvious peaks or outliers.~~

3.5.2 Instrument Detection Calculations

The equations to calculate efficiencies, MDCs, and minimum detectable count rates (MDCRs) at HPNS are based on the methodology and approach used in MARSSIM, Chapter 6, and Nuclear Regulatory Commission (NRC) Regulation (NUREG)-1507, Chapter 6, (*Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* [NRC, 1998]). The instrument equations in this section may be used to calculate adjustments if the changes are approved in writing by a Certified Health Physicist before initial use. The following calculations are examples intended to illustrate the calculation approach.

3.5.2.1 Gamma Surface Activity

Estimating the amount of radioactivity that can be confidently detected using field instruments is performed by adapting the methodology and approach used in MARSSIM (Section 6.7.2.1) and NUREG-1507 (Section 6.8.2) for determining the gamma scan MDC for photon-emitting radionuclides.

The gamma scan MDC (in pCi/g) for areas is based on the area of elevated activity, depth of contamination, and the radionuclide (energy and yield of gamma emissions). The computer code MicroShield® can be used to model expected exposure rates from the radioactive source at the detector probe NaI crystal and includes source-to-detector geometry. The geometry is used to calculate the total flow of photons incident upon the detector crystal, called the gamma fluence rate, ultimately corresponding to an exposure rate that is associated with a count rate in the instrument.

The amount of radiation the detector crystal is exposed to from the modeled source is used to determine the relationship between the detector's net count rate and the net exposure rate (counts per minute per microroentgen per hour [cpm/μR/hr]).

3.5.2.2 Gamma Scan Minimum Detectable Concentration

The minimum detectable number of net source counts in the scan interval is given by s_i, which can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d'), as shown in **Equation 3-2** (MARSSIM Equation 6-8):

Equation 3-2

$$s_i = d'\sqrt{b_i}$$

Where: d' = index of sensitivity (α and β errors [performance criteria])
b_i = number of background counts in scan time interval (count)
i = scan or observation interval (seconds)

For gamma scanning at HPNS, the true and false positive proportions will be set to 95 percent and 5 percent, respectively. From Table 6.5 of MARSSIM, the value of *d'*, representing this performance goal, is 3.28. The MDCR, in cpm, is calculated by **Equation 3-3** (MARSSIM Equation 6-9):

Equation 3-3

$$MDCR = s_i \times (60/i)$$

Where: s_i = minimum detectable number of net source counts in the scan interval
i = scan or observation interval (seconds)

Next, the MDCR is used to calculate the *Surveyor* MDCR by applying a surveyor efficiency factor shown in **Equation 3-4** (MARSSIM Page 6-45):

Equation 3-4

$$MDCR_{Surveyor} = \frac{MDCR}{\sqrt{p}}$$

Where: *MDCR* = minimum detectable count rate
p = surveyor efficiency

After a surveyor efficiency is selected, the relationship between the $MDCR_{surveyor}$ and the radionuclide concentration in soil (in pCi/g) is determined. This correlation requires two steps: (1) establish the relationship between the detector's net count rate and net exposure rate (cpm/µR/hr), and (2) determine the relationship between the radionuclide contamination and exposure rate. The relationship between the detector's net count rate and the net exposure rate may be determined analytically, using reference guidance documents, or obtained from the detector manufacturer. Modeling (using MicroShield®) of the source area is used to determine the net exposure rate produced by a given concentration of radionuclides at a specific distance above the source. The gamma scan MDC is calculated by **Equation 3-5** (MARSSIM Equation 6-11):

Equation 3-5

$$Scan\ MDC = \left(\frac{MDCR_{surveyor}}{\epsilon_{inst}}\right) \times \left(\frac{Radionuclide\ Concentration[pCi/g]}{Exposure\ rate\ [\mu R/hr]}\right)$$

Where: $MDCR_{surveyor}$ = minimum detectable count rate surveyor
ε_{inst} = instrument efficiency (cpm/µR/hr)
Radionuclide Concentration = modeled source term concentration (pCi/g)
Exposure Rate = result of model (µR/hr)

3.5.2.3 Example Gamma Scan Minimum Detectable Concentrations

An example a priori gamma scan MDC calculation is provided here for ^{226}Ra using a Ludlum 2221 with a Model 44-20 (3-inch by 3-inch NaI) detector. This example assumes a background level of 18,000 cpm and 95 percent correct detections and five percent false positive rates resulting in a d' of 3.28. A gamma scan rate of 0.5 meter per second (m/s) (19.7 inches per second) provides an observation interval of two seconds (based on a diameter of approximately 1 m for the modeled area of elevated activity). The $MDCR_{surveyor}$ was then calculated assuming a surveyor efficiency (p) of 1 (assumes automated data logging).

The gamma scan MDC is calculated as follows:

$$s_i = 3.28 * \sqrt{\frac{18{,}000 * 2\,sec}{60\,sec}} = 80\ counts$$

$$MDCR = 80 * \left(\frac{60\,sec}{2\,sec}\right) = 2{,}410\ cpm$$

$$MDCR_{surveyor} = \frac{2{,}410\ cpm}{\sqrt{1}} = 2{,}410\ cpm$$

The relationship between the detector's net count rate and the net exposure rate has been obtained from the detector manufacturer and is 2,300 cpm/μR/hr. The relationship between the radionuclide contamination and exposure rate has been determined by modeling (using MicroShield) the source area to determine the net exposure rate produced by a given concentration of radionuclides at a specific distance above the source. The MicroShield® Version 11.20 model has a source activity of 1 pCi/g of ^{226}Ra, a circular area of elevated activity of 1 m^2, a contaminated zone depth of 15 centimeters (cm; 96 inches), and a soil density of 1.6 grams per cubic centimeter. The modeling code determined an exposure rate at the detector height (dose point) of 10 cm (4 inches) above the source to be 1.130 μR/hr. The gamma scan MDC for this source geometry is calculated as follows:

$$Scan\ MDC = \left(\frac{2{,}410\ cpm}{2{,}300\ cpm/\mu R/hr}\right) \times \left(\frac{1.0\ [pCi/g]}{1.130\ [\mu R/hr]}\right) = 0.93\ pCi/g$$

Additional a priori determinations are provided in **Table 3-7**. The MicroShield® model parameters are identical to those described in the previous example, using either ^{226}Ra with a concentration of 1 pCi/g, or ^{137}Cs with a concentration of 0.113 pCi/g. Note that the measurement geometry and parameters modeled are meant to illustrate an assumption for the calculation. Contamination, if present, may not exist in the same modeled configuration, and the modeled gamma scan MDCs may not apply. As shown in **Table 3-7**, the calculated gamma scan sensitivity for ^{137}Cs is not expected to be sufficient to detect ^{137}Cs at or below the RG. Therefore, compliance with the Parcel B ROD RAO for ^{137}Cs will be based on comparison of the analytical data from soil sampling to the remediation goal presented in Table 3-5.

Table 3-7: A Priori Gamma Scan MDCs

NaI Detector	RG (pCi/g)	Gamma Scan MDC (pCi/g)[b]	
		(6-inch soil depth)	(9-inch soil depth)
Ludlum 44-20, 3x3	^{226}Ra, 1.0[c]	0.93	N/A
	^{137}Cs, 0.113[d]	2.30	N/A

Table 3-7: A Priori Gamma Scan MDCs

NaI Detector	RG (pCi/g)	Gamma Scan MDC (pCi/g)[b]	
		(6-inch soil depth)	(9-inch soil depth)
RS-700	^{226}Ra, 1.0[c]	0.036	0.91
	^{137}Cs, 0.113[d]	1.18	2.78

Notes:
[a] Analytical results will be compared to RGs or background values, whichever is higher.
[b] MDCs calculated based on 6- and 9-inch depth of soil.
[c] The ^{226}Ra RG is 1 pCi/g above background.
[d] Compliance with the ^{137}Cs RG will be based on analytical data from soil sampling. ^{137}Cs is are treated identical to chemical contaminants in that final release decisions are based on the results of the sampling and analysis and are not based on field detection of elevated activity. At 6 inches, the ^{137}Cs MDC is 1.18 pCi/g, higher than the RG.

After field mobilization, MDC calculations will be revised using actual site- and instrument-specific data. Observed MDCs will be provided to regulatory agencies and will be documented in the RACR.

3.5.3 Calibration

Portable survey instruments will be calibrated annually at a minimum, in accordance with American National Standards Institute (ANSI) N323a-1997 *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments* (ANSI, 1997), or an applicable later version. Instruments will be removed from service on or before calibration due dates for recalibration. If ANSI N323 does not provide a standard method, the calibration facility should comply with the manufacturer's recommended method.

3.5.4 Daily Performance Checks

Before the portable survey instruments are used, calibration verification, physical inspection, battery check, and source-response check will be performed in accordance with SOP PR-RP-140, *Radiation Instruments and Equipment* (**Appendix C**), or equivalent. Portable survey instruments will have a current calibration label that will be verified daily prior to use of the instrument.

Physical inspection of the portable survey instrument will include:

- General physical condition of the instrument and detector before each use
- Knobs, buttons, cables, connectors
- Meter movements and displays
- Instrument cases
- Probe and probe windows
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until problems have been corrected. A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual. The instrument will be exposed to the appropriate (alpha, beta, gamma) check source to verify that the instrument response is within the plus or minus 20 percent range determined during the initial response check. The calibration certificates and daily QA/QC records for each instrument used, and the instrument setup test records will be provided in the project report.

If any portable survey instrument, or instrument and detector combination, with a questionable physical condition that cannot be corrected fails any of the operation checks stated in SOP PR-RP-140, *Radiation Instruments and Equipment* (**Appendix C**) or has exceeded its annual calibration date without PRSO approval, the instrument will be put in an "out of service" condition. This is done by placing an "out of service" tag or equivalent on the instrument and securing the instrument or the instrument and detector combination in a separate area such that the instrument and instrument and detector combination cannot be issued for use. The PRSO and RCTs, and their respective supervisors will be notified immediately when any survey instrumentation has been placed "out of service." Instruments tagged as "out of service" will not be returned to service until all deficiencies have been corrected. The results of the daily operation checks will be documented.

3.6 Radiological Investigation Implementation

This section provides guidance on the implementation of radiological investigations for soil. Upon request, soil for split samples will be made available to regulatory agencies during field activities for independent analysis. Locations will be determined in the field, and will allow for sufficient volume for Navy samples and any necessary quality assurance/quality control samples. Sampling, handling, and chain-of-custody procedures will adhere to those established for the specific type of soil sample being collected (e.g. RSY pad sampling, drilling and sampling, surface soil investigation sampling), as established in the Sampling and Analysis Plan (SAP, Appendix A) or the Waste Management Plan (WMP, Section 7).

3.6.1 Pre-Mobilization Activities

Before field investigations begin, several pre-mobilization steps will be completed to ensure that the work can be conducted in a safe and efficient manner. The primary pre-mobilization tasks include training of field personnel and procurement of support services.

The various support services that are anticipated to be required are:

- Radiological analytical laboratory services
- Drilling subcontractor
- Civil surveying subcontractor

- Utility location subcontractor
- Vegetation clearance subcontractor
- Transport (trucking) subcontractor
- Concrete coring subcontractor

3.6.1.1 Training Requirements

Any non-site-specific training required for field personnel will be performed before mobilization to the extent practical. Training requirements are outlined in **Section 6.0**. Medical examinations, medical monitoring, and training will be conducted in accordance with the APP/SSHP and **Section 6.0** requirements.

In addition to health and safety-related training, other training may be required as necessary including but not limited to:

- Aerial lift (for personnel working from aerial lifts)
- Fall protection (for personnel working at heights greater than 5 feet)
- Equipment as required (e.g., fork lift, skid steer, loader, back hoe, excavator)

3.6.1.2 Permitting and Notification

Before initiation of field activities for the radiological investigation, Gilbane will notify the Navy Remedial Project Manager (RPM), Resident Officer in Charge of Construction (ROICC), Radiological Affairs Support Office (RASO), and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained before mobilization.

Gilbane will notify the California Department of Public Health (CDPH) at least 14 days before initiation of activities involving its State of California Radioactive Material License.

3.6.1.3 Pre-construction Meeting

A pre-construction meeting will be held before mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, roles and responsibilities of project personnel, project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, RASO, ROICC, and others as applicable)
- Gilbane (Project Manager, Project QC Manager, PRSO, and Site Safety and Health Officer [SSHO])
- Subcontractors as appropriate

3.6.2 Mobilization Activities

Mobilization activities will include site preparation, movement of equipment and materials to the site, and orientation and training of field personnel.

At least 2 weeks before mobilization, the appropriate Navy personnel, including the Navy RPM, ROICC, and Caretaker Site Office (CSO), will be notified regarding the planned schedule for mobilization and site remediation activities. Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the site.

The temporary facilities will include restrooms, hand-washing stations, and one or more secure storage (Conex) boxes for short- and long-term storage of materials, if needed.

The applicable activity hazard analysis (AHA) forms will be reviewed before work begins.

All equipment mobilized to the site will undergo baseline radioactivity surveys in accordance with **Section 6.0**. Surveys will include static measurements and swipe samples. Equipment that fails baseline surveying will be removed from the site immediately.

3.6.2.1 Locating and Confirming Boundaries

The first step in the radiological investigations is locating and marking the boundaries of the former TUs and SUs. This will be accomplished using best management practices (BMPs) to identify boundaries and depths of the former TUs and SUs based on the previous TtEC reports (e.g., survey reports, drawings, and sketches), field observations (such as GPS locations from geo-referencing, borings, and visual inspection), and durable cover as-built records. Once the boundaries are located, the areas will be marked with paint or pin flags. Boundaries will be based upon completed as-builts of the Parcel B trenches, including any soils outside the original trenches that were removed for remediation purposes, as well as material removed as a result of sidewall sloughing. Field observations will be made during re-excavation activities, particularly with respect to changes in soil texture/appearance, to ensure that re-excavations are performed to within six inches of previous trench limits ~~with 100% confidence~~.

3.6.2.2 Site Preparation

After boundary locating and mark-outs are completed, the following steps will be implemented to prepare the site for investigation and facilitating access.

- A radiologically controlled area (RCA) will be established around each work area and delineated with temporary fencing or caution tape, or equivalent, and the appropriate warning signage will be posted. Access control points will be established and maintained. Radiological screening of personnel, equipment, and materials exiting the RCA will be required. The RCA will be posted consistent with the requirements of the Radiation Protection Plan and SOP PR-RP-160, *Radiation and Contamination Control* (**Appendix C**). Routine surveys and inspections, consisting of dose rate measurements and visual inspections, will be performed along the fence line. Surveys will be performed to ensure that there is no change in dose readings in accessible areas that could negatively affect the public or environment. Any breaches in the fences during site activities will be repaired.

- Stormwater, sediment, and erosion control measures will be implemented to prevent soil from entering and leaving the site as detailed in **Section 8.0**.
- Dust control methods and air monitoring will be implemented during intrusive activities as detailed in **Section 8.0**.
- An independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions will be performed by a third-party utility locator subcontractor following a review of existing utility drawings of the affected areas. The survey will be conducted over the known or suspect areas where underground utilities may exist using ground-penetrating radar or electromagnetic instrumentation. Underground Service Alert will be contacted at least 72 hours before initiating intrusive activities. The results of the geophysical survey will be compared to the available historical drawings and combined with Underground Service Alert markings (if any) to identify locations of underground utilities. Additionally, a visual survey of the area to validate the chosen location also will be conducted. Colored marking paint (or stakes or equivalent) will be used to mark identified utilities, if any, within the proposed work area. A minimum of two feet from the closest observed utility will be maintained to prevent accidental exposure to the utility, based on the utility hazard or importance. If an exception to this condition is required to complete investigation activities, the proposed work will be examined and approved by the Navy ROICC and CSO representatives. Utility lines encountered will be assumed active, unless specifically determined to be inactive through consultation with the subject utility company and with the Navy CSO representative, ROICC, and RPM.
- For both Phase 1 TUs and Phase 2 TUs, the asphalt or soil cover will be removed to expose the target soils. Because of the inherent difficulty expected to determine the exact horizontal boundaries of the previous excavation, to provide access to the TU, and to account for regrading, an additional 1 foot of asphalt or soil material on each side of the historical trench excavation boundary will be removed to allow a sufficient buffer for excavation of trench materials (Phase 1 TUs) and access for the surface gamma scan (Phase 2 TUs). If a trench segment (or portion thereof) is in an area where the durable cover is comprised of two feet of soil and vegetation, the area will be cleared of vegetation, soil, and/or debris to provide site access or otherwise accommodate project activities. Excavated soil will be handled, surveyed, and sampled as described in Section 3.6.3.2. Cleared asphalt, debris, and/or vegetation will be handled according to Section 7.0. Following backfill of the trenches the area will be restored in accordance with Section 3.6.7. After the ~~asphalt~~ durable cover is removed, attempts will be made to confirm the delineation between fill materials and native soils by reviewing cut-and-fill drawings and visual inspections.

- Durable cover materials will require release surveys prior to off-site disposal. Release surveys of the materials will be performed according to SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**).

3.6.3 Phase 1 Trench Unit Investigation

Once all site preparation activities are completed, TU investigation activities will commence.

Each former TU will be excavated to the original excavation limits and evaluated in approximately 152 m^3 ESUs. The excavated material will then undergo radiological assay following the RSY pad process as described in the following subsections. One hundred percent of the Phase 1 ESU soils will undergo gamma scan surveys using real-time gamma spectroscopy equipment in the RSY pad process. Details on the gamma scanning instrumentation can be found in **Section 3.5**.

Once the excavation to the original excavation limits has been completed, over-excavation of at least an additional 6 inches outside the estimated previous boundaries of the sidewalls and bottom will be initiated. This exhumed over-excavated material (SFU) will be maintained separate from the backfill volumes (ESU) and will represent the trench sidewalls and bottom. The over-excavated material (SFU) will be investigated in the same fashion as the excavated soil (ESU) methodology by gamma scan surveys and soil sample collection (RSY pad process). Following completion of gamma scanning activities, the ESU and SFU material will either be returned to the same trench that the material originated from or will be segregated for further investigation.

3.6.3.1 Automated Soil Sorting System Process

An automated soil sorting process will not be used.

3.6.3.2 Radiological Screening Yard Pad Process

Excavated TU material will be assayed using the previously described RSY pad process. Excavated TU materials will be transported to an RSY pad and spread approximately 6 inches thick for processing. Processing activities in the RSY pads will include gamma scan surveys, using a large-volume gamma scintillator equipped with spectroscopy; systematic and biased sampling and analyses; investigation activities (as necessary); radiologically clearing the materials for either reuse or disposal, and transport of the materials off the RSY pads. The objective of the processing activities on the RSY pads is to characterize the material. Material that meets the RGs identified in **Table 3-5** will be used as backfill material or shipped off-site as non-LLRW. Before excavation activities are initiated at each TU, RSY pads will be constructed. Transport routes between the TU and the selected RSY pads will be established and approved by the Navy before excavation activities are initiated at each TU.

3.6.3.2.1 Construction of Radiological Screening Yard Pads

If no existing RSY pads are available for use, pads will be constructed. RSY pads will be constructed with a size limit of 1,000 m^2. Prior to constructing the pad, a gamma scan will be conducted of the underlying ground surface to establish a baseline and to determine if the ambient gamma radiation levels will interfere with RSY pad operations. If the baseline gamma scan of the ground surface identifies areas where the count rate exceeds the instrument-specific IL, the area will be flagged. Flagged areas may be further investigated by a spectral analysis using the RS-700, or equivalent, or by soil sampling, if the ground surface is soil. If results indicate ROC concentrations above the critical level (for spectral analysis) or release criteria (for soil samples), appropriate remediation or relocation of the RSY pad may be necessary and will be determined in consultation with the Navy. Once the RSY area has been cleared of potential material generating elevated gamma scan measurements (if needed), the RSY pad will be constructed and surveyed as follows:

- Area will be covered with 10-mil plastic sheeting (or equivalent).
- Perimeter of the RSY pads will be bermed with biodegradable straw waddles (or equivalent) to prevent run-on and run-off during precipitation events.
- If the existing surface is uneven and/or consists of materials with different radiological characteristics (e.g., soil and asphalt), a 6-inch-thick layer of clean import fill, and/or rock (or equivalent) will be laid across the plastic. The leveling material will be visually inspected to ensure it is free of debris/organic matter and of sufficient clay content to be readily compactable. If the existing surface is even and consists of similar materials, a leveling layer will not be used.
- If used, the leveling soil layer will be compacted via a minimum of four passes with an excavator or similar tracked machine. This will prevent damage to the plastic sheeting when the excavated soil is added or removed.
- If a leveling layer is used, a baseline radiological survey of the constructed RSY pad will be performed prior to the initial placement of excavated soil and a layer of plastic sheeting will be placed on the leveling soil later to prevent cross-contamination from the placement of excavated soil.
- If no leveling layer is used, excavated material may be placed directly on the plastic liner to build the first layer of the RSY pad.

A post-use gamma scan survey will be performed following removal of the RSY screened soil, and again following removal of the RSY pad itself, to verify that cross-contamination of the leveling soil and the underlying surface did not occur. If the gamma scan survey confirms that no cross-contamination occurred, the leveling soil may be disposed as non-LLRW material or may be reused elsewhere at HPNS with Navy concurrence.

3.6.3.2.2 Transfer of Excavated Soil for Processing

Each individual 152 m^3 TU stockpile will be loaded into the RSY pad, spread out, and leveled to a maximum depth of 9 inches for investigation.

Following completion of gamma scan surveys, investigation/remediation of potential radiological anomalies, and collection of radiological soil samples, each surveyed layer on the RSY pad will be covered with plastic (10-mil or equivalent). Additional excavated soil will then be placed on top of the completed layer and the new layer will be surveyed/sampled as described in Section 3.6.3.2. Several layers may be "stacked" in this manner; it is anticipated that approximately 4 to 5 layers will be stacked on average. Should subsequent radiological analysis identify elevated sample results within the RSY stack, the sample location will be remediated by surgically removing the unaffected layers to reach the original sample location. Soil removed from the unaffected layers will be tracked, controlled, and eventually returned to either the approximate original location on the RSY pad or, if radiologically cleared, consolidated with a stockpile containing soil from the same excavation area.

3.6.3.2.3 General Process

The RSY pad process will include gamma scan surveys over 100 percent of the surface area, along with systematic, and biased soil sampling. A minimum of 18 systematic soil samples (as determined in **Section 3.4.1**) will be collected from each pad along with any biased samples based on the results of the gamma scan surveys.

Gamma scan surveys of the spread soil will be performed using a GPS coupled to an appropriate gamma scintillation scanning system, examples of which are provided in **Section 3.5**. The RS-700 gamma detection system will be used as the primary gamma scanning instrument.

Using the RS-700 system, the gamma scan surveys will be performed by scanning straight lines at a rate not to exceed 0.25 m/s with a consistent detector distance from the soil surface (approximately 4 inches above the surface). Generally, RSY pad lift will be gamma scanned as follows (the following description assumes the RSY area is positioned such that the sides align with north, south, east, west directions):

- Begin with the detector positioned in the southwestern corner of the RSY pad at a height of approximately 4 inches above the surface. Orient the system to face north and initiate data collection (detector is automatically logging radiation readings and GPS is automatically logging position readings) so that the system is recording at a rate of one reading per second (or other, as determined by the project Health Physicist).
- Move the detector in the north direction at a not-to-exceed speed of 0.25 m/s.
- Once the detector has reached the edge of the pad, turn the system around (now facing south) and offset the next detector path by the appropriate offset based on the instrument's detector size (e.g., field of view), to allow for a small overlap in the detector field of view.

- Move the detector in the southern direction at a not-to-exceed speed of 0.25 m/s.
- Repeat these steps until the soil on the RSY pad area has been gamma scanned.

The data collected during the gamma scan using the RS-700 are evaluated as described in **Section 3.5.1.1**. If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, Gilbane will further evaluate the gamma scan data and collect biased soil samples. A biased soil sample will be collected from the approximate location of the highest elevated gamma scan measurement. A minimum of 3 biased samples (or 4 biased samples when ^{232}Th is an ROC) will be collected in every SU. Biased samples will be collected from the location of the highest scan z-score location for each gamma-emitting ROC, as well as from the highest scan z-score location from ROI 10 (gross gamma). For ROCs that have multiple RS-700 ROIs (i.e. ^{226}Ra), the highest scan z-score among those ROIs will be selected for biased sampling. In addition, biased samples will also be collected if gamma static measurement identify elevated locations as described in Section 3.3.1. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated elevated areas. Material with potentially elevated concentrations will remain segregated until completion of the investigation activities. Additionally, if soil sampling indicates areas of soil potentially elevated above the RGs, and it is confirmed that the soil contains contamination, and the soil material originates from an SFU, an in-situ investigation of the open trench will be performed at the excavation location of the soil.

Each 1,000 m^2 RSY pad area will be plotted using VSP software (or equivalent) to determine the location of the 18 systematic soil samples. The systematic soil samples will be plotted using a random start square grid using the VSP software (or equivalent). Soil samples will be collected from the surface at a depth of 0 to 6 inches. The technique for locating systematic samples is provided in **Section 3.4.2**. Soil samples will be containerized and submitted to an off-site laboratory with appropriate chain-of-custody documentation as established in the SAP (**Appendix A**).

Soil processed by the RSY pad process and subsequently staged for off-site disposal or on-site reuse will be staged pending evaluation of off-site analytical results and Navy approval for disposal or reuse. If elevated sample results are identified by off-site analysis, Gilbane will notify the Navy and determine a suitable soil rescreening process. SFU sampling locations with results that exceed RGs or background, whichever is higher, will be remediated by additional soil excavation as directed by the Navy.

Following completion of gamma scan surveys, sampling, and any potential investigation activities, the excavated material approved for reuse will be returned to the same trench that the material originated from.

3.6.4 Phase 2 Trench Unit Investigation

Investigations of the Phase 2 TUs will consist of a combination of gamma scan surveys and soil samples.

Gamma scan surveys of the surface soil will be performed using one or a combination of the gamma detectors listed in **Table 3-6** (or equivalent). The gamma scan surveys will generally be performed using the same protocols and methods as those in the RSY pads. Of the accessible surface of the Phase 2 TUs, 100 percent will be gamma scanned using a GPS coupled to a large-volume gamma scintillator, equipped with real-time gamma spectroscopy and data logging.

Data sets will be transferred from the data logger onto a personal computer to create spreadsheets and to map the gamma scan survey results. Data obtained during the surface gamma scan surveys, including gross gamma and individual radionuclide spectral measurements, will be analyzed to identify areas where surface radiation levels appear to be greater than the radionuclide-specific ILs using ROI-peak identification tools.

If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, Gilbane will further evaluate the gamma scan data and collect biased soil samples. ~~The biased soil sample will be collected from the approximate location of the highest elevated gamma scan measurement.~~ A minimum of 3 biased samples (or 4 biased samples when ^{232}Th is an ROC) will be collected in every SU. Biased samples will be collected from the location of the highest scan z-score location for each gamma-emitting ROC, as well as from the highest scan z-score location from ROI 10 (gross gamma). For ROCs that have multiple RS-700 ROIs (i.e. ^{226}Ra), the highest scan z-score among those ROIs will be selected for biased sampling. In addition, biased samples will also be obtained if gamma static measurement identify elevated locations as described in Section 3.3.1. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated areas of elevated activity.

The systematic boring locations will be cored down to approximately 6 inches below the depth of previous excavation within each TU boundary. Soil samples will be collected as described in **Section 3.6.4.1**. Sanitary sewer and storm drain lines were sometimes installed on bedrock. In these situations, sampling of bedrock will not be performed. If refusal is encountered within 6 inches of the expected depth of the trench, the soil sample will be collected from the deepest section of the core. If refusal is encountered more than 6 inches above the expected depth of the trench, the sample location will be moved to avoid the subsurface obstruction.

To acquire three samples from each boring, one surface and one floor sample will be collected from each sample core. The sample cores will be gamma scanned along the entire length of each core using a Ludlum Model 44-20 3-inch by 3-inch NaI (or equivalent). Gamma scan measurement results will be evaluated against the IL to identify core section with elevated gamma radiation. Core sections that exceed the IL will have biased soil samples collected to investigate the potential for small areas of elevated activity in fill. If no core section exceeds the IL, a biased sample will be collected from the core segment with the highest gamma scan reading that was not already sampled, for a total of at least three samples from each core.

Additionally, systematic samples will be collected from sidewall locations every 50 linear feet, representative of each of the trench sidewalls. The boring locations will be located within 1 meter of the previous sidewall excavation limits and will extend to the maximum previous excavation depth. In the same action described in the previous paragraph, core sections will be retrieved, scanned, and sampled such that at least three samples will be collected from each of the six boring locations. An example graphic showing the sample locations representing the TU sidewalls is provided on **Figure 3-4**.

If GPS reception is available, soil sample locations will be position-correlated with GPS data and recorded. If GPS reception is not available, a reference coordinate system will be established to document gamma scan results and soil sample locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Remediation of soil with analytical results above the RGs and background will be performed by excavation of the identified location of the elevated activity or by excavation of the complete TU (for Phase 2 TUs) for further processing using the RSY pad process. Following excavation, a minimum of five bounding confirmation samples will be collected at the lateral and vertical extents to confirm the removal of contaminated soil. If a Phase 2 TU is excavated in its entirety, it will be investigated following the process described for a Phase 1 TU in **Section 3.6.3**. Material with potentially elevated activity will remain segregated until completion of the investigation activities.

3.6.4.1 Subsurface Soil Sample Collection

Subsurface soil samples will be collected in accordance with the SAP (**Appendix A**). Subsurface soil samples will be collected using drilling-rig-mounted equipment to collect samples with thin-walled tube sampling or split-spoon sampling. When needed, other methods may be considered and applied. Specific sampling methods used will be documented in the field, and deviations from the work plan will be described in the final report. Disposable sampling equipment will be used whenever practical and will be disposed immediately after use. If reusable sampling equipment is used, decontamination between sampling locations will be performed following the SAP (**Appendix A**). Generally, drilling and retrieving the boring using the thin-walled tube method will be as follows:

- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM International (ASTM) D 1587 standard.

- The sampler is lowered into the hole so that the bottom of the sample tube rests on the bottom of the hole. The sampler is advanced by a continuous, relatively rapid downward motion. The sampler is withdrawn from the soil formation as carefully as possible to minimize disturbance of the sample. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch internal diameter sampler may be used.
- Once retrieved from the hole, the tube is carefully cut open to maintain the material in the tube. Drill cuttings in the upper end of the tube are removed, and the upper and lower ends of the tube are sealed. The soil tube will be turned over to the project geologist and RCT for sample preparation, radiological surveys, and containerization.

Generally, drilling and retrieving the boring using the split-spoon sampling method will be performed as follows:

- Using a drilling rig, a hole is advanced to the desired depth. The samples are then collected following the ASTM D 1586 standard.
- The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically, this is 24 inches. The sampler is driven down using a weight ("hammer"). To obtain enough volume of sample for subsequent laboratory analysis, a 3-inch-internal-diameter sampler may be used.
- Upon removal of the soil core from the ground, the soil core will be turned over to the project geologist and RCT for sample preparation, radiological surveys, and containerization. Once retrieved from the hole, the sampler is carefully split open to maintain the material in the tube.

Once the soil tube has been cut open or the core has been split open, soil examination and sample collection will occur as follows:

- The geologist will log the soil boring to provide accurate and consistent descriptions of soil characteristics. Soil boring logs will be maintained in accordance with the SAP (**Appendix A**).
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing gravel. The depth, recovery position, and gamma scan measurement information will be correlated to each sample extracted from the core.
- A minimum of 1,000 grams of soil (approximately 1 quart) are required to complete all required analyses. If sample size requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the original sample location within the core and compositing the sample.
- The entire mixed sample will be placed in the designated laboratory sample container and the range of soil depths included in the sample will be recorded in the field logbook.

- Samples will be identified, labeled, and cataloged according to the SAP (**Appendix A**) and **Section 3.6.7**, and then placed into the appropriate sample cooler (if required) for transport to the laboratory. Custody of the sample will be maintained in accordance with the SAP (**Appendix A**).
- When a field duplicate sample is required (1 for every 10 field samples collected), the sample will be evenly split following mixing of the material and removal of extraneous material, and each aliquot placed into an appropriately labeled sample container.
- If insufficient soil for sampling is obtained from the original borehole, an adjacent location will be considered.

3.6.5 Surface Soil Survey Unit Investigation

Surface soil SUs will be characterized in a similar fashion to the RSY pad process described in **Section 3.6.3**, using a combination of gamma scan surveys and systematic and biased soil sampling.

Gamma scan surveys will be performed using one or a combination of the gamma detectors listed in **Table 3-6**. The gamma scan surveys will be performed using the same protocols and methods as those for the RSY pads. One hundred percent of the accessible surface will be gamma scanned using a large volume gamma scintillator, equipped with real-time gamma spectroscopy and data logging.

If GPS reception is available, gamma scan surveys will be position-correlated with GPS data. If GPS reception is not available, a reference coordinate system will be established to document gamma scan measurement locations. The reference coordinate system will consist of a grid of intersecting lines referenced to a fixed site location or benchmark. If practical, the GPS coordinates of the fixed location or benchmark will be recorded.

Data sets will be transferred from the data logger onto a personal computer to create spreadsheets and, if feasible, gamma scan survey results will be mapped. Data obtained during the gamma scan surveys, including gross gamma, and individual radionuclide spectral measurements, will be analyzed to identify areas where surface radiation levels appear to be greater than the radionuclide-specific ILs using ROI-peak identification tools.

The data collected during the gamma scan using the RS-700 will be evaluated as described in **Section 3.5.1.1**.

If gamma scan surveys indicate areas of potentially elevated activity in soil above the ILs (**Section 3.3.1**), an investigation of the potential area of elevated activity will be initiated. At a minimum, a gamma scan survey will be performed and biased soil samples will be collected. The biased soil sample will be collected from the approximate location of the highest elevated gamma scan measurement. If areas displaying elevated activity are collocated, an attempt will be made to locate the area with the highest gamma scan results and designate it as the biased sample location to represent the collocated areas of elevated activity. Potentially elevated material will remain segregated until completion of the investigation activities.

Areas known to contain or suspected of containing radioactive materials will be isolated pending removal of the material. Discrete radioactive objects (or highly concentrated and localized soil contamination) will be identified during gamma scan surveys. Measurements exceeding instrument-specific ILs will be delineated to the extent possible based on gamma surveys prior to removal.

If the anomaly is confirmed to be radioactive material, it will be removed. Removal actions will involve evaluating the area around the coordinates of the suspected radioactive material. A minimum of 1 foot in each direction of the surrounding soil will be removed and designated as LLRW.

After the radioactive material and surrounding soil are excavated, the resulting excavation will be resurveyed by gamma scan. If elevated gamma emitters persist, further gamma scan surveys of the soil will be performed until the source of the elevated gamma activity is found and removed. Four or more post-excavation bounding samples will be collected from the soil at the edge of the bounding excavation and beneath the discrete source (e.g., radium object), if present, to verify that the contamination was removed.

If the source of elevated radioactivity above the RGs and background cannot be readily identified as a point source, the limits of the anomaly will be identified, and the excavated material will be segregated for disposal. Sampling locations with results that exceed RGs or background, whichever is higher, will be remediated by soil excavation of the SU.

The location of the 18 systematic soil samples will be determined using VSP software, or equivalent, and located using GPS if available, or the established reference coordinate system used during the gamma scan survey. The systematic and biased soil samples from each SU will be collected based on the process described in **Section 3.6.5.1** and submitted to the off-site analytical laboratory for analysis according to the SAP (**Appendix A**).

3.6.5.1 Surface Soil Sample Collection

Prior to surface soil sampling, the necessary gamma scan measurements will be collected as described above. Surface soil samples will be collected in accordance with the SAP (**Appendix A**). Disposable sampling equipment will be used whenever practical and will be disposed immediately after use. If reusable sampling equipment is used, decontamination will be performed between sampling locations in accordance with the SAP (**Appendix A**). Generally, the surface soil sample will be collected as follows:

- A clean trowel, hand auger, or other tool will be used to remove a small area (about 3 inches in diameter) of soil to a depth of 6 inches.
- The removed soil will be transferred directly into a clean stainless steel bowl for mixing.
- The soils removed from the sample location will be visually described in the field logbook in accordance with the SAP (**Appendix A**). Color, moisture, texture, and clast composition (i.e., serpentine, shale, sandstone, chert, gabbro) will be identified.
- The sample for radiological analyses will be mixed in the field by breaking the sample into small pieces and removing overburden gravel and biological material. The entire mixed sample, or aliquot thereof, will be placed in the designated laboratory sample container.
- Samples will be identified, labeled, and cataloged according to the SAP (**Appendix A**) and **Section 3.6.7**, and then placed into the appropriate sample cooler (if required) for transport to the contract laboratory. Custody of the sample will be maintained in accordance with the SAP (**Appendix A**).
- A minimum of 200 grams of soil (approximately 1 cup) is required to complete all required analyses.

3.6.6 Sample Identification

Each soil sample will be uniquely identified at the time of collection as described in the following subsections.

3.6.6.1 Phase 1 Trench Unit Samples

Sample identifications (IDs) from the Phase 1 soil trench unit investigation will be established using the following format:

AABB-CCC-NNNA-DDDB

Where: AA = facility (HP for Hunters Point will be used in this work plan)
BB = site location (PB for Parcel B will be used in this work plan)
CCC = excavation soil unit or sidewall floor unit
NNN = former trench unit number
A = alpha-numeric digit of each soil unit (beginning with A, in sequential order)
DDD = numeric sample digit (beginning with 001, in sequential order)
B = biased sample location identifier (only added to biased sample IDs)

For example, the first soil sample collected from the third soil unit of backfill TU material excavated from the former TU 130 will be identified as follows:

HPPB-ESU-130C-001

In this example, "HPPB" identifies Hunters Point Parcel B, "ESU" identifies excavation soil unit, "130" identifies the soil unit as being excavated from the former Trench Unit 130, "C" represents the third soil unit created from excavating this former TU, and "001" identifies the first sample.

3.6.6.2 Phase 2 Trench Unit Samples

Sample IDs from the Phase 2 soil trench unit investigation will be identified using the following format:

AABB-CCC-NNN-EEFF-GG-DDDB

Where: AA = facility (HP for Hunters Point will be used in this work plan)
BB = site location (PB for Parcel B will be used in this work plan)
CCC = excavation soil unit (ESU) or sidewall floor unit (SFU)
NNN = former trench unit number
EEFF = two-digit sample interval in feet below ground surface (bgs) (EE feet = top of sample interval and FF feet = bottom of sample interval). EE and FF are whole numbers such that a value of "01" represents "1 foot bgs." Surface samples (samples collected from the 0.0- to 0.5-foot depth interval) will be designated as 000H; H is for half foot. If the surface sample is collected from a depth interval other than a half foot, the H designation will still be used; however, a note will be included in the daily activity report to indicate the actual depth sampled.
GG = soil boring number within the TU
DDD = numeric sample digit (beginning with 001, in sequential order)
B = biased sample location identifier (only added to biased sample IDs)

For example, the first soil sample collected from the surface of sidewall TU material from the former TU 60 will be identified as follows:

HPPB-SFU-060-000H-01-001

In this example, "HPPB" identifies Hunters Point Parcel B, "SFU" identifies sidewall floor unit, "060" identifies the unit as being from the former Trench Unit 060, "000H" represents the depth interval for a surface sample (000H is the agreed-upon code established for surface samples as explained above), "01" identifies soil boring number 01, and "001" identifies the first sample.

3.6.6.3 Surface Soil Survey Unit Samples

Sample IDs from the surface soil SU investigation will be identified using the following format:

AABB-CCC-SUNN-DDDB

Where: AA = facility (HP for Hunters Point will be used in this work plan)
BB = site location (PB for Parcel B will be used in this work plan)
CCC = building site name (current or former building number)
SUNN = survey unit number
DDD = numeric sample digit (beginning with 001, in sequential order)
B = biased sample location identifier (only added to biased sample IDs)

For example, the second soil sample collected from former Building 114 in SU 1 will be identified as follows:

HPPB-114-SU01-002

In this example, "HPPB" identifies Hunters Point Parcel B, "114" identifies former Building 114, "SU01" identifies the unit as being SU 1, and "002" identifies the second sample.

3.6.7 Site Restoration

The open excavations will be backfilled with the excavated soil upon concurrence from the Navy. The excavated material will be returned to the same trench that the material originated from. If additional backfill is required, a clean import source will be identified and used. Imported fill will be sampled and analyzed in accordance with the SAP (**Appendix A**) and will be approved by the Navy before use. If the trench excavations are water-logged, crushed rock or gravel will be placed as bridging material. With Navy concurrence, radiologically cleared recycled fill materials (e.g., crushed asphalt) may be used for backfill. The backfill will be compacted to 90 percent relative density by test method ASTM D1557. Once the excavated areas have been backfilled, the durable cover will be repaired "in kind" to match pre-excavation action conditions.

3.6.7.1 Deconstruction of Radiological Screening Yard Pads

Following completion of radiological screening and with Navy approval, the RSY pads will be deconstructed. Before deconstruction, the RSY pads will be radiologically screened and released in accordance with **Section 6.0**. The area will be down-posted for the deconstruction activities. If tThe RSY pad material cannot be reused on-site, it will be consolidated on-site for off-site disposal at an approved disposal facility~~. If the RSY pad buffer material cannot be reused on-site, it will be disposed of off-site at an approved disposal facility.~~ (**Section 7.0**). Following deconstruction, the area will be restored to pre-removal action conditions.

3.6.7.2 Decontamination and Release of Equipment and Tools

Decontamination of materials and equipment will be conducted at the completion of fieldwork. Numerous decontamination methods are available for use. If practical, manual decontamination methods will be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be accomplished by using detergents for non-porous surfaces with contamination present. Chemicals selected for decontamination should be those that will minimize the creation of mixed waste. Decontamination activities will be conducted using SOP PR-RP-160, *Radiation and Contamination Control* (**Appendix C**).

3.6.8 Demobilization

Demobilization will consist of surveying, decontaminating, and removing equipment and materials, cleaning the project site, inspecting the site, and removing temporary facilities. Survey of equipment and materials will be performed in accordance with

Section 6.6, and decontamination will be performed in accordance with **Section 3.6.8.2**. Demobilization activities will also involve collection and disposal of contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate (**Section 7.0**).

3.7 Radiological Laboratory Analysis

Samples will be containerized and submitted to an off-site laboratory with appropriate chain-of-custody documentation as established in the SAP (**Appendix A**). All laboratory analyses will be performed by a Department of Defense Environmental Laboratory Accreditation Program or National Voluntary Laboratory Accreditation Program-accredited laboratory certified by the State of California to perform analyses. All soil samples will be retained for possible CDPH confirmatory analysis until the final RACR for Parcel B is issued.

Analysis will be based on the site-specific ROCs listed in **Table 3-4**, and in accordance with the SAP (**Appendix A**) and as follows:

- Soil samples will be assayed using gamma spectroscopy analysis for ^{137}Cs and ^{226}Ra. Soil samples from Building 157 also will be assayed for ^{60}Co. Gamma spectroscopy data will be reported for gamma-emitting ROCs by the laboratory after a full 21-day ingrowth period.
  - If the gamma spectroscopy laboratory results indicate a concentration of ^{226}Ra above the RG in a sample, the sample will be analyzed using alpha spectroscopy for uranium isotopes (specifically ^{238}U~~, ^{235}U,~~ and ^{234}U), thorium isotopes (specifically ~~^{232}Th,~~ ^{230}Th~~, and ^{228}Th~~), and ^{226}Ra to evaluate equilibrium conditions. Additional details regarding the equilibrium evaluation are provided in **Section 5.6**. All detected isotopes will be reported.
  - If laboratory results indicate a concentration of ^{137}Cs above the RG in a sample, the sample will be analyzed by gas flow proportional counting for ^{90}Sr and by alpha spectroscopy for ^{239}Pu.
- At least 10 percent of randomly selected samples will be analyzed by gas flow proportional counting for ^{90}Sr.
  - If laboratory results indicate a concentration of ^{90}Sr above the RG in a sample, the sample will be analyzed via alpha spectroscopy for ^{239}Pu.
- At Buildings 103, 140, and 142 where ^{239}Pu is a ROC, at least 10 percent of randomly selected samples will be analyzed by alpha spectroscopy for ^{239}Pu.

If the results following the full ingrowth are below the RGs shown in **Table 3-5**, additional analyses are not required.

All laboratory data packages will have independent data verification and data validation performed to demonstrate that the data meet the project objectives. Following independent data verification and validation, the sample data will be evaluated as described in **Section 5.0**.

Table 3-1: Phase 1 Soil Trench Units

Former TU Number	Original TU Excavation		Sidewalls + Bottom		Total		
	Estimated Volume[a] (m^3)	Number of ESUs[b]	Estimated Volume of 6-Inch Over-Excavation (m^3)	Number of SFUs[b]	Volume (m^3)	Number of ESUs and SFUs	Number of Systematic Samples[c]
~~4~~	~~466~~	~~3~~	~~75~~	~~1~~	~~541~~	~~4~~	~~72~~
13	312	2	71	1	383	3	54
19	976	7	80	1	1,056	8	144
21	1,080	7	113	1	1,193	8	144
23	996	7	105	1	1,101	8	144
~~26~~	~~778~~	~~5~~	~~81~~	~~1~~	~~859~~	~~6~~	~~108~~
~~33~~	~~920~~	~~6~~	~~114~~	~~1~~	~~1,034~~	~~7~~	~~126~~
~~36~~	~~659~~	~~4~~	~~111~~	~~1~~	~~770~~	~~5~~	~~90~~
39	700	5	111	1	811	6	108
42	583	4	109	1	692	5	90
45	542	4	74	1	616	5	90
47	690	5	115	1	805	6	108
48	33	1	7	1	40	2	36
49	1,238	8	111	1	1,349	9	162
50	1,855	12	125	1	1,980	13	234
50A	1,856	12	129	1	1,985	13	234
51	1,665	11	92	1	1,757	12	216
51A	1,311	9	18	1	1,329	10	180
53	306	2	100	1	406	3	54
54	1,608	11	137	1	1,745	12	216
55	463	3	57	1	520	4	72
56	1,670	11	140	1	1,810	12	216
57	1,125	8	102	1	1,227	9	162
59	703	5	95	1	798	6	108
60	707	5	110	1	817	6	108
65	985	7	80	1	1,065	8	144
130	144	1	33	1	177	2	36
~~131~~	~~33~~	~~1~~	~~7~~	~~1~~	~~40~~	~~2~~	~~36~~
132	122	1	21	1	143	2	36
186	308	2	41	1	349	3	54
				Total:	~~22,578~~ 24,154	~~163~~179	~~2,934~~3,222

Notes:

[a] Determined by the estimated backfill quantity from Table 3-1 in the *Removal Action Completion Report, Parcel B, Hunters Point Naval Shipyard, San Francisco, California* (Navy, 2012).

[b] Calculated by dividing the estimated volume by 152 m^3, which is based on a volume of 1,000 m^2 x 6-inches (0.1524 m) = 152 m^3 (~300 tons of soil).

[c] Assumes 18 systematic samples in each unit.

Table 3-2: Phase 2 Soil Trench Units

Former TU Number	Surface Area[a] (m^2)	Linear Length (~~ft~~m)	Number of Systematic Borings in Backfill Material	Number of ~~Systematic~~ Samples from ~~Fill Borings in~~ Backfill Material	Number of Sidewall Borings[b]	Number of ~~Systematic~~ Samples from Sidewalls~~, Borings and Bottom~~
1	585	470	18	~~36~~54	19	~~114~~57
2	585	409	18	~~36~~54	17	~~99~~51
3	255	166	18	~~36~~54	7	~~51~~21
4	500	343	18	54	14	42
5	388	226	18	~~36~~54	10	~~63~~30
6	421	225	18	~~36~~54	9	~~63~~27
7	128	139	18	~~36~~54	6	~~45~~18
8	264	290	18	~~36~~54	12	~~75~~36
9	626	358	18	~~36~~54	15	~~90~~45
10	615	373	18	~~36~~54	15	~~93~~45
11	762	341	18	~~36~~54	14	~~87~~42
12	905	471	18	~~36~~54	19	~~114~~57
14	680	449	18	~~36~~54	18	~~108~~54
15	380	241	18	~~36~~54	10	~~66~~30
16	225	204	18	~~36~~54	9	~~60~~27
17	794	431	18	~~36~~54	18	~~102~~54
18	226	151	18	~~36~~54	7	~~48~~21
~~19~~	~~875~~	~~405~~		~~36~~	~~99~~	
20	531	408	18	~~36~~54	17	~~99~~51
22	577	302	18	~~36~~54	13	~~78~~39
24	693	435	18	~~36~~54	18	~~105~~54
25	105	77	18	~~36~~54	4	~~33~~12
26	539	397	18	54	16	48
27	751	474	18	~~36~~54	19	~~114~~57
28	181	120	18	~~36~~54	5	~~42~~15
29	295	149	18	~~36~~54	6	~~48~~18
30	701	240	18	~~36~~54	10	~~66~~30
33	759	357	18	54	14	42
36	739	372	18	54	15	45
37	250	347	18	~~36~~54	14	~~87~~42

40	175	96	18	~~36~~54	4	~~36~~12
41	148	42	18	~~36~~54	2	~~27~~6
~~42~~	~~920~~	~~482~~		~~36~~	~~114~~	
43	918	326	18	~~36~~54	14	~~84~~42
44	600	326	18	~~36~~54	14	~~84~~42

Table 3-2: Phase 2 Soil Trench Units (continued)

Former TU Number	Surface Area[a] (m^2)	Linear Length (~~ft~~m)	Number of Systematic Borings in Backfill Material	Number of ~~Systematic~~ Samples from ~~Fill Borings in~~ Backfill Material	Number of Sidewall Borings[b]	Number of ~~Systematic~~ Samples from Sidewall~~s~~ Borings and Bottom
46	513	295	18	~~36~~54	12	~~78~~36
~~51A~~	~~911~~	~~122~~		~~36~~	~~42~~	
52	467	288	18	~~36~~54	12	~~75~~36
~~53~~	~~457~~	~~337~~		~~36~~	~~84~~	
~~55~~	~~393~~	~~221~~		~~36~~	~~63~~	
58	940	3~~36~~54	18	~~36~~54	14	~~84~~42
~~60~~	~~703~~	~~352~~		~~36~~	~~87~~	
61	795	285	18	~~36~~54	12	~~75~~36
62	492	205	18	~~36~~54	9	~~60~~27
63	717	228	18	~~36~~54	10	~~63~~30
64	446	160	18	~~36~~54	7	~~108~~21
125	159	190	18	~~36~~54	8	~~51~~24
126	212	209	18	~~36~~54	9	~~60~~27
127	204	256	18	~~36~~54	11	~~69~~33
128	457	505	18	~~36~~54	21	~~117~~63
131	48	57	18	54	2	6
		Total:	810	~~1,656~~2,430	531	~~3,501~~1,593

Notes:

[a] From Table 3-1 of the *Removal Action Completion Report, Parcel B, Hunters Point Naval Shipyard, San Francisco, California* (Navy, 2012).

[b] Assumes a boring every 50 linear feet on each trench sidewall

Table 3-3: Surface Soil Survey Units

Site	Former SU Name	Surface Area (m^2)	Number of Systematic Samples
Building 103	A	84	18
	B	99	18
	C	74	18
	D	74	18
	E	74	18
	F	99	18
	G	99	18
Former Building 114	001	716	18
	002	317	18
Former Building 142	001	235	18
	002	237	18
	003	407	18
Former Building 157	005	375	18
	006	< 1,000	18
	007	653	18
		Total:	306

4.0 Building Investigation Design and Implementation

This section describes the DQOs, ROCs, RGs, ILs, and radiological investigation design and implementation for Parcel B buildings.

4.1 Data Quality Objectives

The DQOs for the building investigation are as follows:

- **Step 1-State the Problem**: The Technical Team evaluated building data and found evidence of potential manipulation and falsification. The findings call into question the reliability of the data and there is uncertainty whether radiological contamination was present or remains in place. Therefore, the property is unable to be transferred as planned. Based on the uncertainty and the description of radiological activities in the HRA, there is a potential for residual radioactivity to be present on building interior surfaces.
- **Step 2-Identify the Objective**: The primary objective is to determine whether site conditions are compliant with the Parcel B ROD RAO (Navy, 2009).
- **Step 3-Identify Inputs to the Objective**: The inputs include alpha-beta static, alpha-beta scan, and alpha-beta swipe sample data on building and reference area surfaces.
- **Step 4-Define the Study Boundaries**: The study boundaries are accessible interior surfaces of Buildings 103, 113, 113A, 130, 140 (consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping* [TtEC, 2011]), and 146 (**Figure 4-1**). The building floor (i.e., Class 1 SUs) are depicted on **Figure 4-2** through **Figure** 4-94-11.
- **Step 5-Develop Decision Rules:**
  - If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed.
  - If the investigation results demonstrate exceedances of the RGs determined from on a point-by-point comparison with the RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, then remediation will be conducted followed by preparation of a RACR.
  - The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel B ROD RAO through the use of multiple lines of

evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

- **Step 6-Specify the Performance Criteria:** The data evaluation process for demonstrating compliance with the Parcel B ROD (Navy, 2009) is presented as follows, depicted on **Figure** ~~4-10~~4-12, and described in detail in **Section 5.0**:
  - Compare each net alpha and net beta result to the corresponding RG presented in **Section 4.3**. If all results are less than or equal to the RGs, then compliance with the Parcel B ROD RAO is achieved.
  - Compare survey data to appropriate RBA data from HPNS as described in **Section 5.0**. Multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include, but is not limited to, population-to-population comparisons, use of an MLE or BTV, and graphical comparisons. If survey data are consistent with NORM or anthropogenic background, site conditions comply with the Parcel B ROD RAO.
  - If any result is greater than the RG and cannot be attributed to NORM or anthropogenic background, remediation will be conducted as directed by the Navy.
- **Step 7-Develop the Plan for Obtaining Data:** Radiological investigations will be conducted on floors, wall surfaces, and ceiling surfaces of Buildings 103, 113, 113A, 130, and 146; and on accessible interior surfaces of Building 140 consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping* (TtEC, 2011).

4.2 Radionuclides of Concern

The ROCs for Parcel B Buildings 103, 113, 113A, 130, 140, and 146, as identified in the HRA and in subsequent investigations, include ^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr and are presented in **Table 4-1**.

Table 4-1: Building Radionuclides of Concern

Building	ROCs	Reference
Building 103	^{90}Sr, ^{137}Cs, ^{239}Pu	NAVSEA, 2004
Building 113	^{90}Sr, ^{137}Cs, ^{239}Pu	NAVSEA, 2004
Building 113A	^{137}Cs, ^{226}Ra	NAVSEA, 2004
Building 130	^{137}Cs, ^{226}Ra	NAVSEA, 2004
Building 140	^{90}Sr, ^{137}Cs, ^{226}Ra, ^{239}Pu	NAVSEA, 2004
Building 146	^{90}Sr, ^{137}Cs, ^{226}Ra	NAVSEA, 2004

4.3 Remediation Goals

The building data from the radiological investigations will be evaluated to determine whether site conditions are compliant with the RAO in the Parcel B ROD (Navy, 2009). The RAO is to prevent exposure to ROCs at concentrations that exceed RGs for all potentially complete exposure pathways. These RGs for structures, equipment, and waste are presented in **Table 4-2** for each of the ROCs identified for the applicable buildings. Also identified for each ROC is the primary particle type emitted during the ROC's decay or during the ROC's radioactive progeny's decay.

Table 4-2: Building Remediation Goals from Parcel B ROD

ROC	Particle Emissions	RGs for Structures (dpm/100 cm^2)	RGs for Equipment, Waste (dpm/100 cm^2)
^{137}Cs	b	5,000	5,000
^{239}Pu	a	100	100
^{226}Ra	a, b	100	100
^{90}Sr	b	1,000	1,000

Notes:
dpm/100 cm^2 = disintegration(s) per minute per 100 square centimeters

Data collected from building surfaces during this investigation represent the total (fixed and removable) gross activity on the surface that may result from radiations from multiple radionuclides. Because these survey data are radiation-specific (a and b) but not radionuclide-specific, they cannot be attributed to a particular ROC. Instead, the survey data will be compared to the most restrictive building-specific RG_a and RG_b as presented in **Table 4-3**. For each building, the RG_a is chosen as the structure's lowest RG for an alpha-emitting ROC, and the RG_b is chosen as the structure's lowest RG for a beta-emitting ROC.

Table 4-3: Building-Specific Remediation Goals for Parcel B Work Plan

Building	RG_a (dpm/100 cm^2) and ROC	RG_b (dpm/100 cm^2) and ROC
Building 103	100 (^{239}Pu)	1,000 (^{90}Sr)
Building 113	100 (^{239}Pu)	1,000 (^{90}Sr)
Building 113A	100 (^{226}Ra)	5,000 (^{137}Cs)
Building 130	100 (^{226}Ra)	5,000 (^{137}Cs)
Building 140	100 (^{226}Ra/^{239}Pu)	1,000 (^{90}Sr)
Building 146	100 (^{226}Ra)	1,000 (^{90}Sr)

4.4 Radiological Investigation Design

This section describes the design of the radiological investigations, including scan and static measurements and swipe sampling. The radiological investigation design is primarily based on methods, techniques, and instrument systems to demonstrate compliance with the Parcel B ROD RAO (Navy, 2009). For Building 140, the radiological investigation design is consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping* (TtEC, 2011), as modified by Gilbane's technical proposal accepted by the Navy, dated August 22, 2018, with the ultimate requirement to demonstrate compliance with the Parcel B ROD RAO.

To the extent possible, manual data entries will be reduced or eliminated through the use of electronic data collection and transfer processes.

4.4.1 Building Survey Overview

The radiological survey of the impacted Parcel B buildings has two primary components (scan measurements and static measurements), which are discussed in the following subsections. In addition, swipe samples will be collected to assess potential alpha-beta removable contamination. If needed, swipe samples will be analyzed off-site to speciate the radionuclides present. Building material samples and, for Building 140, sediment samples, may be collected and analyzed off-site to characterize areas of interest identified by the surveys.

4.4.1.1 Scan Measurements

Scan measurements are performed on building surfaces to locate radiation anomalies indicating residual radioactivity that may require further investigation or remediation. As noted in Section 4.3, the scanning design is dictated by the most restrictive RGα and RGβ values for the building. Where appropriate, scan measurements will be performed using the assumptions of equilibrium described in **Section 4.5.5**.

4.4.1.2 Static Measurements

Static measurements will be the primary means of demonstrating compliance with the Parcel B ROD RAO. Gross alpha and beta static measurements will be performed so that the measurement MDC is below the most restrictive RG_α and RG_β values for the building.

Static measurements will be performed in each SU and in the RBAs. They will consist of measurements in scaler mode for simultaneous alpha-beta counting using a Ludlum Model 43-68 gas proportional detector, Ludlum Model 43-93 plastic scintillation detector, or other appropriate instrument. While 1-minute count times were used in the following example calculations, static count times will be updated during investigations to meet DQOs using instrument-specific information. Static measurements will be performed on a systematic sampling grid or biased to locations identified by the alpha-beta scanning surveys.

The number of systematic static measurements performed will be based on the guidance described in MARSSIM Section 5.5.2.2 using the unity rule as the example basis for calculating the minimum static measurement frequency. Even if the MARSSIM-recommended or other statistical tests are not used to evaluate site data, these calculations serve as a basis for determining the number of static measurements per SU to be performed. The number of biased static measurements will be determined based on results of scan surveys.

MARSSIM Section 5.5.2.2 defines the method for calculating the number of static measurements when residual radioactivity is uniformly present throughout an SU. Therefore, determining the number of static measurements will be based on the following factors:

- RG for radioactivity on structural surfaces (UBGR)
- LBGR
- Estimate of variability (standard deviation [s]) in the reference area and the SUs
- Shift (D=UBGR-LBGR)
- Relative shift ([UBGR-LBGR]/s); see **Equation 4-1**
- Decision error rates for making a Type I or Type II decision error that the mean or median concentration exceeds the RG (determined via MARSSIM Table 5.2)

Each of the preceding factors is addressed in the following paragraphs. Example data are provided to assist in explaining the process for calculating the minimum static measurement frequency. Actual numbers of static measurements for SUs will be based on reference area data once they become available. When using the unity rule, the RG is defined as 1 (unitless) plus background. As a basis for the calculations, the background surface activity concentration is assumed to be 0.5.

MARSSIM defines a gray region as the range of values in which the consequences of decision error on whether the residual surface activity is less than or exceeds the RG are relatively minor. The RG of 1 above background (0.5) was selected to represent the UBGR (1.5). The LBGR is the median concentration in the SU, and the retrospective power will be determined after the survey is completed. Given the absence of usable data prior to performing the investigation activities, MARSSIM Section 2.5.4 suggests arbitrarily selecting the LBGR as half the RG. Therefore, for this example, the LBGR = 0.5 + 0.5 = 1. Assuming the UBGR equals the RG, then D = 1.5 – 1.0 = 0.5 for this example.

MARSSIM defines σ as an estimate of the standard deviation of the measured values in the SU. Because SU data will not be available until the investigation activities are completed, MARSSIM recommends using the standard deviation of the RBA as an estimate of s. Given the absence of data prior to performing the investigation activities, an arbitrary value of 0.25 has been selected as an estimate of σ for this example.

The relative shift is calculated based on MARSSIM guidance (Section 5.5.2.2), as shown in **Equation 4-1**.

Equation 4-1

$$\frac{\Delta}{\sigma} = \frac{(UBGR - LBGR)}{\sigma} = \frac{(RG - LBGR)}{\sigma} = \frac{(1.5 - 1.0)}{0.25} = 2.0$$

The minimum number of samples assumes the ROC concentration in the SU exceeds the RG. A Type I decision error is deciding that the ROC concentration in the SU is less than the RG when it actually exceeds the RG. To minimize the potential for releasing ~~soil~~ building surfaces with concentrations above the RG, the Type I decision error rate is set at 0.01. A Type II decision error is deciding that the ROC concentration exceeds the RG when it is actually less than the RG. To protect against remediating building surfaces with concentrations below the RG, the Type II decision error rate is set at 0.05, as recommended by MARSSIM.

MARSSIM Table 5.3 lists the minimum number of static measurements to be performed in each SU and RBA based on the relative shift and decision error rates. For a relative shift of 2, a Type I decision error rate at 0.01, and Type II decision error rate of 0.05, MARSSIM Table 5.3 recommends a minimum of 18 static measurements in each SU and RBA.

The minimum number of static measurements per SU will be developed based on the variability observed in the RBA data. The DQA of SU data will include a retrospective power curve (based on MARSSIM Appendix I guidance) to demonstrate that enough static measurements were performed to meet the project objectives. If necessary, additional static measurements may be performed to comply with the project objectives.

4.4.2 Radiological Background

Building 404 will serve as the primary RBA in the investigation of Parcel B Building 140 (**Figure 4-1**). Building 404 is a non-impacted, unoccupied former supply storehouse constructed in 1943 (see Reference 1598 in NAVSEA, 2004). From the same construction era and with materials similar to those of the impacted Parcel B Building 140, Building 404 has 43,695 square feet of concrete floors, a wooden superstructure, prepared roll or composition roof, and drywall offices.

At least 18 static measurements will be taken on each surface material in the RBA that is representative of the material in the building SUs. Alternate RBAs may be identified and used if needed based on site-specific conditions identified during the building investigations.

4.4.3 Survey Units

Parcel B buildings will be divided into identifiable SUs similar in area and nomenclature to the previous investigation of each building. **Table 4-4** lists the SUs, classification, and areas by building. Generally, impacted floor surfaces and the lower 2 meters of remaining impacted wall surfaces will form Class 1 SUs of no more than 100 m^2 each. The remaining impacted upper wall surfaces and ceilings will generally form Class 2 SUs of no more than 2,000 m^2 each. There are no Class 3 SUs.

Table 4-4: Building ~~140~~ Summary Table

Building	Classification	Survey Units			Corresponding Figure(s)
		Number	Total	Area (m^2)	
103	Class 1	SU-001 to SU-010, SU-018 to SU-026, SU-032	20	1,248	4-2, 4-3
	Class 2	SU-011 to SU-014, SU-016, SU-017, SU-027 to SU-031, SU-033	12	1,259	4-2, 4-3
113	Class 1	SU-001 to SU-025	25	1,620	4-4
	Class 2	SU-026 to SU-033	8	1,757	N/A
113A	Class 1	SU-001 to SU-011, SU-016	12	465	4-5
	Class 2	SU-012 to SU-015	4	488	N/A
130	Class 1	SU-001 to SU-034, SU-040	35	2,428	4-6
	Class 2	SU-035 to SU-039	5	2,481	N/A
140	Class 1	N/A[a]	---	---	4-7
146	Class 1	SU-001 to SU-007, SU 012 to SU-022, SU-041	19	758	4-~~6, 4-9~~4-10, 4-11
	Class 2	SU-023 to SU-024, SU-030 to SU-040, SU-042	14	867	N/A

Notes:

[a] Data to be collected consistent with the *Technical Memorandum to Support Unrestricted Radiological Release of Building 140 Including the Suction Channel and Discharge Piping* (TtEC, 2011)

Areas with known releases have been remediated and recovered during past investigations such that there are no areas of suspected surface or volumetric contamination remaining in Parcel B buildings. This investigation measures only the remaining, accessible and impacted surfaces through a combination of static and swipe measurements. The SU designations and floor boundaries will remain the same as those used in the historical TtEC investigations.

The floor plans and floor SUs are shown for each building on **Figure 4-2** through **Figure 4-**11~~8~~. An example figure is provided that depicts SU-specific details for a Class 1 SU (**Figure** ~~4-11~~4-13). **Figure** ~~4-11~~4-13 is a two-dimensional representation of Building 103 (SU-001) and shows the Class 1 floor and lower wall surfaces, and intended static measurement and swipe sample locations.

Building-specific information regarding the Parcel B buildings is provided in the following paragraphs and in **Table 4-4**.

4.4.3.1 Building 103

The floors and walls less than or equal to 2 meters above the respective floor areas are divided into 20 Class 1 survey units (less than 100 m^2 of floor area each), and the upper portions of the interior walls and ceiling are divided into 12 Class 2 survey units (less than 1,000 m^2). The first floor survey units are shown in **Figure 4-2** and the second floor survey units are shown in **Figure 4-3**. Following asbestos abatement activities, SU-013 and SU-015 were combined into a single Class 2 SU-013, and another Class 2 survey unit, SU-033, was added. In addition, the crawl space is divided into seven Class 1 survey units (SUs A through G) that are being investigated as Parcel B soil (see **Section 3.0**). The limiting alpha-emitting ROC 103 is ^{239}Pu and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.2 Building 113

The floors and walls less than or equal to 2 meters above the respective floor areas are divided into 25 Class 1 survey units (less than 100 m^2 of floor area each) and eight Class 2 survey units (**Figure 4-4**). The upper portion of the interior walls and ceiling are Class 2 survey units. The limiting alpha-emitting ROC is ^{239}Pu and the limiting beta-emitting ROC is ^{90}Sr.

4.4.3.3 Building 113A

The floors and walls less than or equal to 2 meters above the respective floor areas are divided into 12 Class 1 survey units (less than 100 m^2 of floor area each) and four Class 2 survey units (**Figure 4-5**). The upper portion of the interior walls and ceiling are Class 2 survey units. The limiting alpha-emitting ROC is ^{226}Ra and the limiting beta-emitting ROC is ^{137}Cs.

4.4.3.4 Building 130

The floors and walls less than or equal to 2 meters above the respective floor areas are divided into 35 Class 1 survey units (less than 100 m^2 of floor area each) and five Class 2 survey units (**Figure 4-6**). The upper portion of the interior walls and ceiling are Class 2 survey units. The limiting alpha-emitting ROC is ^{226}Ra and the limiting beta-emitting ROC is ^{137}Cs.

4.4.3.5 Building 140

The interior floors and walls less than or equal to 2 meters above the respective floor areas are divided into three Class 1 survey units less than 100 m^2 of floor area each (**Figure 4-7**). In addition, other areas to be surveyed include Installed electrical cabinets, flooded pump pit, discharge piping, and the discharge channel. The limiting alpha-emitting ROCs are ^{226}Ra and ^{239}Pu, and the limiting beta-emitting ROC is ^{90}Sr.

The HRA (NAVSEA, 2004) indicates that Building 140 is radiologically impacted because of its association with Drydock 3. Drydock 3 was historically used as a decontamination facility for ships that participated in atomic weapons testing, as the possible location of removal of radium-bearing devices from ships during maintenance, and as the former location of radium-bearing devices. The various decontamination methods for ships that participated in atomic and nuclear weapons testing included sandblasting of shipboard components and acid washing of desalinization systems.

During dewatering operations, residual decontamination wastes may have been drawn into the collector channel located at the bottom of Drydock 3 and into the suction channel and then forced through the discharge piping using the pumps housed in Building 140, thereby potentially contaminating the discharge channel and subsequently entering the bay. Because of the construction of the dewatering system from Drydock 3, only the interior portions of the suction channel, discharge piping, and discharge channel could possibly have become contaminated with decontamination media.

Gilbane will recollect data as presented in the Final Technical Memorandum to Support Unrestricted Radiological Release of Building 140 including the Suction Channel and Discharge Piping (TtEC, 2011). To achieve this, the anticipated tasks to be performed within Building 140 include:

- Initial inspection of the building, suction channel and discharge piping
- Cleanup of debris
- Scanning of electrical cabinets
- Evaluation of the pump pit to include an underwater video inspection, collection of sediment samples (if possible), collection of water samples, and collection of debris samples
- A final status survey of the building interior and discharge channel using the same survey units as presented in the Final Technical Memorandum (TtECI, 2011). The building and survey unit layouts are shown on Figures 4-7, 4-8, and 4-9.
- Collection of samples from the discharge piping

The Parcel B ROD indicates that Building 140 is eligible for inclusion on the National Register of Historic Places (Navy, 2009). The aforementioned tasks to be performed within Building 140 will have no effect on the structural nor exterior elements of the building, nor will they involve removal of interior equipment unless that equipment is found to be radiologically contaminated. Therefore, the anticipated activities within Building 140 are not expected to affect nor disturb the historical elements of the building.

4.4.3.6 Building 146

The floors and walls less than or equal to 2 meters above the respective floor areas are divided into 22 Class 1 survey units (less than 100 m^2 of floor area each) and 18 Class 2 survey units. The upper portion of the interior walls and ceiling are Class 2 survey units. The first floor survey units are shown in **Figure 4-**108 and the second floor survey units are shown in **Figure 4-**119. During the previous investigation, it became necessary to remove some of the walls and portions of the flooring material to facilitate access to the drain lines. Once this work was completed, 19 Class 1 survey units and 14 Class 2 survey units remained (SU-008 through SU-011 and SU-025 through SU-029 were not used). The limiting alpha-emitting ROC is ^{226}Ra and the limiting beta-emitting ROC is ^{90}Sr.

4.4.4 Reference Coordinate System

Survey unit scan lanes and static measurement locations will be marked using a consistent reference coordinate system throughout the building. In the absence of other technologies, locations will reference from the southernmost and westernmost points in the SU.

4.5 Instrumentation

Investigation data will be collected using position-sensitive ~~proportional counters (PSPCs),~~ gas proportional counters, and swipe sample counters as described herein.

4.5.1 Position-Sensitive Proportional Counters

A position-sensitive proportional counter will not be used~~Large area surface scan and static measurements for alpha and beta radiations will be performed using PSPCs such as the Radiation Safety and Control Services, Inc. (RSCS) Surface Contamination Monitor (SCM) or equivalent instrument. The RSCS SCM simultaneously acquires alpha-beta data from motor-controlled dual detectors moving over a surface at a fixed rate between 1.25 and 12.5 centimeters per second (cm/s). Detector functions, movement, and response are controlled through a Survey Information Management System (SIMS). The SIMS is also used to log, display, and interpret investigation data and generate survey reports. The detectors are configured in parallel and the system can identify the location of each reading within 5 cm along a detector's length. Operated in rolling (dynamic) mode for scanning, the SCM acquires data for each 5 cm of detector width and every 5 cm of forward travel. The data for the resulting 25-square-centimeter (cm^2) area is binned, then combined as one-fourth of the overall 100 cm^2 response~~.

4.5.2 Gas Proportional Detectors

Gas proportional detectors, such as the large area Ludlum Model 43-37, small area Ludlum Model 43-68, or equivalent instruments, will be used for scan measurements ~~in areas that are not accessible to or practicable for the RSCS SCM~~. The Ludlum Model 43-37 detector physical size is 2.5 by 15.9 by 46.4 cm (H by W by L) with an active area of 584 cm^2. The Ludlum Model 43-68 is 10 by 11.7 by 19.8 cm, with an active area of 126 cm^2. Scanning speed is surveyor-controlled, and data are automatically logged when used with an appropriate data-logging scaler/ratemeter, such as the Ludlum Model 2360 or equivalent. The Ludlum Model 43-68 may also be used to perform static measurements.

4.5.3 Scintillation Detector

Alpha-beta scintillation detectors may also be used for scanning and static measurements. The Ludlum Model 43-93 has an active detector area of 100 cm^2 and simultaneously counts alpha radiation using a zinc sulfide scintillator and beta radiation using a thin plastic scintillator.

4.5.4 Alpha-Beta Sample Counter

Swipe samples to assess removable activity will be performed using an alpha-beta plastic scintillation counter, such as the Ludlum Model 3030 Alpha-Beta Sample Counter or equivalent. The Ludlum Model 3030 has an active detector area of 20.3 cm^2 and simultaneously counts alpha-beta radiation from 5.1 cm swipe papers loaded into a single sample tray.

4.5.5 Instrument Efficiencies

Manufacturer-provided parameters, including the detector physical (active) areas, total (4π) efficiencies, and background count rates, are provided in **Table 4-5**. These parameters will be updated as appropriate during the investigation for each instrument used. In accordance with NUREG-1507, during survey activities total 4π efficiencies for alpha/beta instruments will be determined by multiplying the reported 2π instrument efficiency (ε_i) from the instrument calibration and a source efficiency (ε_s) of 0.5 for beta-emitters with maximum beta energies exceeding 400 keV, and 0.25 for beta-emitters with maximum beta energies between 150 and 400 keV and for alpha-emitters. In the following sections, manufacturer-provided 4π efficiencies are used to illustrate the example calculations.

Table 4-5: Typical Survey Instrument Efficiencies and Background Count Rates from Manufacturers

Parameter	~~RSCS SCM~~	Ludlum Model 43-37	Ludlum Model 43-68	Ludlum Model 43-93	Ludlum Model 3030
Type of Measurement	~~Scan~~	Scan	Scan/Static	Scan/Static	Swipes
Detector active area, A (cm^2)	~~100~~	584	126	100	20.3
Width in direction of scan, d (cm)	~~20~~	13.335	8.8	6.94	NA
Alpha total efficiency (4π) for ^{239}Pu	~~NA~~	0.175	0.175	0.20	0.37
Beta total efficiency (4π) for ^{99}Tc		0.20	0.20	0.15	0.27
Beta total efficiency (4π) for ^{90}Sr/^{90}Y	~~0.90~~	0.20	0.20	0.20	0.26
Beta total efficiency (4π) for ^{137}Cs		NA	NA	NA	0.29
Alpha background (cpm)	~~1~~	< 10	≤ 3	≤ 3	≤ 3
Beta background (cpm)	~~636~~	800-1300	350	≤ 300	≤ 50

Notes:
^{90}Y = yttrium-90
^{99}Tc = technetium-99
< = less than
≤ = less than or equal to
NA = not applicable

The response of a detector to the incident radiations from building surfaces differs from the values in **Table 4-5** depending on the presence and state of equilibrium of radioactive progenies. All of the ROCs in **Table 4-1** have radioactive progenies that emit alpha or beta particles during their decay. The concentration of each progeny relative to its parent depends on its parent's decay fraction and the equilibrium fraction of the entire series or chain. The radioactive progeny of ^{90}Sr and ^{137}Cs equilibrate in less than a day since their progeny half-lives are measured in minutes. Due to the 24,000 year half-life of ^{239}Pu, its progeny generally are of no concern. However, ^{226}Ra are naturally occurring and has a radon isotope as progeny. ~~Since radon (^{222}Rn) is a gas, a fraction of its concentration may escape the building area before decaying and the relative abundance (equilibrium fraction) of the subsequent progenies is reduced.~~ The radon decay products typically have an equilibrium fraction of 0.4 indoors (see Question 17 in USEPA, 2014) such that the progeny of radon (^{222}Rn) is only present at 40 percent of the ^{222}Rn concentration. An equilibrium fraction of 1 is used for conservatism, such that any radon progeny are assumed to remain on the contaminated surface.

In **Table 4-6**, each ROC and its progeny is listed along with the associated type of particle emitted during decay, the fraction of times that particle type is emitted, the radon decay product abundance relative to ^{222}Rn and the 4-π efficiencies and 4-π weighted efficiencies for the four example detector types for building investigations. The 4-π weighted efficiencies for each radionuclide and detector is the product of its decay fraction, equilibrium fraction, and 4-π efficiency. The total alpha (or beta) 4-π weighted efficiencies for ^{226}Ra and ^{90}Sr are the summed alpha (or beta) 4-π weighted efficiencies of themselves and their progeny. To illustrate, the alpha response (4-π efficiency) of the Ludlum Model 43-37-1 to pure ^{226}Ra is 0.175 (or 17.5 counts per 100 disintegrations of ^{226}Ra). However, ^{226}Ra exists in partial equilibrium with its radioactive progeny, and for each disintegration of ^{226}Ra, there are 3.2 alpha particles and 1.6 beta particles formed. ~~The resultant total alpha 4-π weighted efficiency for the RSCS SCM and the ^{226}Ra chain is 0.188 x 3.2 = 0.602.~~ Consistent with MARSSIM Section 4.3.2, the weighted efficiencies provided in **Table 4-6** are used for the instrument sensitivity calculations described in the remainder of this section.

Table 4-6: Detector Efficiencies for Each ROC and Alpha- or Beta-emitting Progeny

Parent ROC and Alpha- or Beta-emitting Progenies	Particle Emission	Decay Fraction	Equilibrium Fraction	4π Efficiencies (Estimated)					4π Weighted Efficiencies (Estimated)				
				~~RSCS SCM~~	Ludlum Model 43-37	Ludlum Model 43-68	Ludlum Model 43-93	Ludlum Model 3030	~~RSCS SCM~~	Ludlum Model 43-37	Ludlum Model 43-68	Ludlum Model 43-93	Ludlum Model 3030
^{137}Cs	Beta	1.00	1.00	~~0.900~~	0.200	0.200	0.200	0.290	~~0.900~~	0.200	0.200	0.200	0.290
^{239}Pu	Alpha	1.00	1.00	~~0.188~~	0.175	0.175	0.200	0.370	~~0.188~~	0.175	0.175	0.200	0.370
^{226}Ra	Alpha	1.00	1.00	~~0.188~~	0.175	0.175	0.200	0.320	~~0.188~~	0.175	0.175	0.200	0.320
^{222}Rn	Alpha	1.00	1.00	~~0.188~~	0.175	0.175	0.200	0.370	~~0.188~~	0.175	0.175	0.200	0.370
^{218}Po	Alpha	1.00	0.40	~~0.188~~	0.175	0.175	0.200	0.370	~~0.075~~	0.070	0.070	0.080	0.148
^{214}Pb	Beta	1.00	0.40	~~0.900~~	0.200	0.200	0.200	0.260	~~0.360~~	0.080	0.080	0.080	0.104
^{214}Bi	Beta	1.00	0.40	~~0.900~~	0.200	0.200	0.200	0.260	~~0.360~~	0.080	0.080	0.080	0.104
^{214}Po	Alpha	1.00	0.40	~~0.188~~	0.175	0.175	0.200	0.370	~~0.075~~	0.070	0.070	0.080	0.148
^{210}Pb	Beta	1.00	0.40	~~0~~	0	0	0	0	~~0~~	0	0	0	0
^{210}Bi	Beta	1.00	0.40	~~0.900~~	0.200	0.200	0.200	0.260	~~0.360~~	0.080	0.080	0.080	0.104
^{210}Po	Alpha	1.00	0.40	~~0.188~~	0.200	0.175	0.200	0.370	~~0.075~~	0.080	0.070	0.080	0.148
Total ^{226}Ra alphas			***3.20***						~~*0.602*~~	***0.570***	***0.560***	***0.640***	***1.134***
Total ^{226}Ra betas			***1.60***						~~*1.080*~~	***0.240***	***0.240***	***0.240***	***0.312***
^{90}Sr	Beta	1.00	1.00	~~0.900~~	0.200	0.200	0.200	0.260	~~0.900~~	0.200	0.200	0.200	0.260
^{90}Y	Beta	1.00	1.00	~~0.900~~	0.200	0.200	0.200	0.260	~~0.900~~	0.200	0.200	0.200	0.260
Total ^{90}Sr betas			***2.00***						~~*1.800*~~	***0.400***	***0.400***	***0.400***	***0.520***

Notes:
Total alphas or betas = sum of (decay fraction x equilibrium fraction)
^{210}Bi = bismuth-210
^{210}Pb = lead-210
^{210}Po = polonium-210
^{214}Pb = lead-214
^{214}Po = polonium-214
^{218}Po = polonium-218

4.5.6 Calibration

Portable survey instruments will be calibrated annually at a minimum, in accordance with ANSI N323 (ANSI, 1997), or an applicable later version. Instruments will be removed from service on or before calibration due dates for recalibration. If ANSI N323 does not provide a standard method, the calibration facility should comply with the manufacturer's recommended method.

4.5.7 Daily Performance Checks

Before the portable survey instruments are used, calibration verification, physical inspection, battery check, and source-response check will be performed in accordance with SOP PR-RP-140, *Radiation Instruments and Equipment* (**Appendix C**). Portable survey instruments will have a current calibration label that will be verified daily before use.

Physical inspection of the portable survey instrument will include:

- General physical condition of the instrument and detector before each use
- Knobs, buttons, cables, connectors
- Meter movements and displays
- Instrument cases
- Probe and probe windows
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until problems have been corrected. A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual. The instrument will be exposed to the appropriate (alpha or beta) check source, to verify that the instrument response is within the plus or minus 20 percent range determined during the initial response check. The calibration certificates and daily QA/QC records, and instrument setup test records for each instrument used will be provided in the project report.

If any portable survey instrument, or instrument and detector combination, having a questionable physical condition that cannot be corrected fails any of the operation checks stated in SOP PR-RP-140, *Radiation Instruments and Equipment* (**Appendix C**), the instrument will be put in an "out of service" status. This is done by placing an "out of service" tag or equivalent on the instrument and securing the instrument or the instrument and detector combination in a separate area such that the instrument and instrument and detector combination cannot be issued for use. The PRSO and RCTs and their respective supervisors will be notified immediately when any survey instrumentation has been placed "out of service." Instruments tagged as "out of service" will not be returned to service until all deficiencies have been corrected. The results of the daily operation checks, discussed above, will be documented.

4.5.8 Instrument Detection Calculations and Investigation Levels

Instrument-specific parameters used for building investigations are calculated in the following subsections. These include the average scan rate, ILs, alpha detection probabilities and MDCs for scan measurements and the ILs and MDCs for static measurements. These calculations will be updated during building investigations (**Section 4.6.3**) using information from calibration sheets and background measurements for each instrument.

4.5.8.1 Alpha-Beta Scan Rate

While scanning, the period that a moving detector spends above an area of elevated activity, or the dwell time (in seconds), depends on the rate of scanning (cm/s) and the size of the area of elevated activity (cm^2). The detector dwell time (*t*) is also called the detector residence time or observation interval (*i*) in some references. The size of any area of elevated activity cannot be known before investigation, so the conventional approach is to assume a typical size for the area (e.g., 100 cm^2) and choose a scan rate that provides a reasonable value for t. Generally, dwell times in the 0.5- to 2-second range are considered reasonable. If the 100 cm^2 area of elevated activity is 10 cm x 10 cm, then these dwell times would result in average detector scan rates, *v*, between 5 and 20 cm/s.

Average scan rates for each instrument used for scanning will be determined during instrument preparations (**Section 4.6.3.1**) to meet required detection sensitivities. Movement of a ~~PSPC, such as the RSCS SCM, is motor-controlled and has a fixed scan rate, v, which is typically between 1.25 and 12.5 cm/s. Movement of other~~ large area detector~~s~~, such as the Ludlum Model 43-37, is surveyor-controlled and the average scan rate will be monitored during scanning and verified during data evaluation.

4.5.8.2 Alpha-Beta Scan Investigation Levels

Scan data are compared to scan ILs. ILs are instrument-, ROC-, and surface material-specific surface activity levels, in units of the instrument's response (cpm). Scan data that exceed an applicable scan IL will be investigated using biased measurements (**Section 4.6.3.4**). Scan ILs will be updated during instrument preparations (**Section 4.6.3.1**).

The measurements for alpha and beta surface activity occur simultaneously during scanning; however, the signal detection theory for alpha emitters differs greatly from that of beta emitters. Surface conditions and other factors result in relatively low probabilities that alpha particles emitted from sources on a surface will reach the detector, while beta scanning provides a more reliable and efficient method for the detection of beta emitters. Given that ^{226}Ra has progeny that emit beta particles, the collection of beta scanning measurements will supplement and verify alpha scans where ^{226}Ra is an ROC.

Scan ILs are calculated using **Equation 4-2** and the detector-specific information in **Table 4-5** and **Table 4-6**. To enable direct comparison to the alpha ratemeter output during scanning, the RG for each alpha-emitting ROC is converted from units of dpm/100 cm^2 to cpm (beta) using **Equation 4-2**, which is based on the discussion of data conversion in MARSSIM Section 6.6.1. The beta scan IL is determined in a similar manner.

Equation 4-2

$$Scan\ IL_{(\alpha\ or\ \beta)}(cpm) = RG_{(\alpha\ or\ \beta)} \cdot \varepsilon_{T\,(\alpha\ or\ \beta)} \cdot \left(\frac{A}{100\ cm^2}\right) + R_{B\,(\alpha\ or\ \beta)}$$

Where: $RG_{(\alpha+\beta)}$ = remediation goal for alpha- or beta-emitting ROC (dpm/100 cm^2)
$\varepsilon_{T\,(\alpha\ or\ \beta)}$ = detector total (4-π) efficiency (counts per disintegration), equal to 2-π instrument efficiency (ε_i) multiplied by surface efficiency (ε_s)
A = detector probe physical (active) area (cm^2)
$R_{B\,(\alpha\ or\ \beta)}$ = alpha or beta background count rate (cpm)

For illustration, calculated scan ILs are presented in **Table 4-7** for each ROC and for three detector models. Site-specific scan ILs will be determined during instrument preparations (**Section 4.6.3.1**).

Example: *^{226}Ra alpha scan IL for the Ludlum 43-37~~RSCS SCM~~.*

$$\text{Scan IL } {}^{226}Ra_{,\alpha}\ \ (\text{Ludlum 43-37}\cancel{\text{RSCS SCM}}) = 100 \cdot 0.570\cancel{602} \cdot \left(\frac{100}{100}\right) + 1 = 58.0\cancel{61.2}\ cpm$$

Where:
$RG^{226}Ra_{,\alpha}$ = 100 dpm/100 cm^2
$\varepsilon_{T,\alpha}$ = 0.570~~802~~ (total weighted alpha efficiency for ^{226}Ra, from **Table 4-6**)
A = 100 cm^2 (combined area of four 25 cm^2 bins)
$R_{B,a}$ = 1 cpm

Table 4-7: Preliminary Instrument Scan Investigation Levels

ROC	~~RSCS SCM (cpm)~~		Ludlum 43-37 (cpm)		Ludlum 43-68 (cpm)	
	~~Alpha~~	~~Beta~~	Alpha	Beta	Alpha	Beta
^{137}Cs	~~NA~~	~~5,436~~	NA	6,890	NA	1,435
^{239}Pu	~~49~~	~~NA~~	107	NA	23	NA
^{226}Ra	~~61~~	~~780~~	337	1,190	72	205
^{90}Sr	~~NA~~	~~2,436~~	NA	3,386	NA	679

Notes:
NA = not applicable

4.5.8.3 Probability of Alpha Detection for High-background Detectors

The measurements for alpha and beta surface activity occur simultaneously during scanning; however, the signal detection theory for alpha emitters differs greatly from that of beta emitters. For alpha scanning, one verifies that while scanning at rate v, there is a specified probability (typically 90 percent) that surface activity present at the RG_α will be detected.

Equation 4-3 (adapted from MARSSIM Equation 6-14 is used for detectors having higher background rates (i.e., 5 to 10 cpm) to determine the probability of recording at least two alpha counts, P(n ≥ 2), while passing over an area contaminated at the RG_α, during t. It is assumed that all the elevated activity is contained in a 100 cm^2 area and that the detector passes over the area in one or multiple scan passes.

~~To achieve the sensitivity needed to detect alpha-emitting ROCs at the release criteria, where possible the SCM will be used in the coincidence, with two detectors hard-mounted to each other at a set distance. The system will be operated at a target speed of 2.5 to 5 cm/s, with the detector approximately 0.5 inch from the surface.~~ The probability of detecting two or more counts due to a source at the RG_α is given by **Equation 4-3** (MARSSIM Equation 6-14), as follows:

<u>Equation 4-3</u>

$$P(n \geq 2) = 1 - (1 + \frac{(GE + B)t}{60})(e^{\frac{-(GE+B)t}{60}})$$

Where: *P(n ≥ 2)* = probability of getting two or more counts during the time interval *t* (percent)
t = time interval (seconds)
G = contamination activity (disintegrations per minute [dpm]) = equal to the RG_α
E = total efficiency (4-π), equal to 2-π instrument efficiency (ε_i), multiplied by surface efficiency (ε_s)
B = background count rate (cpm)

~~Because the detectors associated with the SCM are manufactured to the same specifications, the efficiency of each detector is similar. Therefore, the probability of obtaining two or more counts on each detector as they traverse the same source (assumed to be 100 dpm for the purposes of this calculation) is the square of the probability for a single detector.~~

~~Typical alpha background values observed with the SCM are less than 5 cpm/100 cm², The total detector efficiency (4-π) of the SCM for the alpha emission from ²²⁶Ra is assumed to be 0.602, according to **Table 4-6**. The detector width is 20 cm in the direction of travel. Survey speed for alpha emitters is 2.5 cm/s (1 inch per second), resulting in a dwell time of 8 seconds. Using these parameters, **Equation 4-3** is solved as follows:~~

$$\cancel{P(n \geq 2) = 1 - \left(1 + \frac{(100x0.602 + 5)8}{60}\right)\left(e^{\frac{-(100x0.602+5)8}{60}}\right) = 99.8\%}$$

~~Where: *P(n ≥ 2)* = probability of getting two or more counts during the time interval *t* (percent)~~
~~*t* = 8 seconds~~
~~*G* = 100 dpm~~
~~*E* = 0.602 (total weighted alpha efficiency for ^{226}Ra, from **Table 4-6**)~~
~~*B* = 5 cpm~~

~~As calculated above, the probability of getting two or more counts during the SCM observation interval of 8 seconds when surveying a 100-dpm hotspot is equal to 99.8 percent at a scan speed of 2.5 cm/s. Alpha detection probabilities and associated scan speeds for large area detectors will be updated as needed during survey.~~

~~preparation (Section 4.6.3.1) to reflect instrument-, ROC-, and surface material-specific information.~~

4.5.8.4 Probability of Alpha Detection for Small Area Detectors

The alpha count rate on various surfaces will average approximately 2 cpm with a small area Ludlum Model 43-68 detector. When using a 126 cm^2 or smaller detector, scanning for alpha emitters differs because the expected background response of most alpha detectors is close to zero. A single count in the defined residence time will result in a second measurement of equal duration. One or more additional counts will require investigation with a static measurement as described in **Section 4.6.3.4**.

The probability of detecting given levels of alpha surface contamination for smaller detectors can be calculated by use of Poisson summation statistics. Given a known measurement interval and a surface contamination release limit, the probability of detecting a single count for the measurement interval to be used during this project and sample data from a typical Ludlum Model 43-68 setup is given by MARSSIM Equation 6-12, shown as **Equation 4-4**:

<u>Equation 4-4</u>

$$P(n \geq 1) = 1 - e^{\frac{-(GEd)}{60v}}$$

Where: *P(n ≥ 1)* = probability of observing a single count
G = contamination activity = RG_α
E = total efficiency (4-π), equal to 2-π instrument efficiency (ε_i), multiplied by surface efficiency (ε_s)
d = width of detector in direction of scan (cm)
v = scan speed (cm/s)

Equation 4-4 may be solved as follows:

$$P(n \geq 1) = 1 - e^{\frac{-(100x0.560\cancel{602}x8.8)}{60x2.5}} = 96.3e\cancel{7.1}\%$$

Where: *P(n ≥ 1)* = probability of observing a single count
G = 100 dpm
E = 0.560~~602~~ (**Table 4-6**)
d = 8.8 cm
v = 2.5 cm/s

As calculated above, the probability of getting one or more counts during a Ludlum Model 43-68 scan moving at 2.5 cm/s when surveying a 100 dpm hotspot is equal to 96.3~~7.1~~ percent. Alpha detection probabilities and associated scan speeds for small area detectors will be updated as needed during survey preparation (**Section 4.6.3.1**) to reflect instrument-, ROC-, and surface material-specific information.

4.5.8.5 Beta Scan Minimum Detectable Concentration

The rate at which each detection instrument traverses across the surface being surveyed is necessarily detector- and radionuclide-specific and varies with accepted error rates, surveyor efficiency, and surface beta background. We assume that 95 percent true positive (α = 0.95) and 5 percent false positive (β = 0.95) rates are required, such that d' = 3.28 from MARSSIM Table 6.5. A value of 0.5 for p, the surveyor efficiency, is typical for surveyor-controlled detectors and 1.0 for motor-controlled detectors. The β scan MDC is calculated using **Equation 4-5** (adapted from MARSSIM, Equation 6-10 [USEPA et al., 2000]). Instruments will be selected for scanning to ensure that their beta scan MDC is less than or equal to the RGβ for the building from **Table 4-3**. **Equation 4-5** through **Equation 4-7** are derived as follows:

Equation 4-5

$$\beta\ scan\ MDC\ (dpm/100\ cm^2) = \frac{MDCR}{\sqrt{p}\cdot\varepsilon_{i,\beta}\cdot\varepsilon_{s,\beta}\cdot\frac{A}{100\ cm^2}}$$

Where: *MDCR* = minimum detectable count rate
p = surveyor efficiency
$\varepsilon_{i,\beta}$ = detector (2-π) beta efficiency (counts per disintegration)
$\varepsilon_{s,\beta}$ = surface (2-π) beta efficiency (counts per disintegration)
A = detector physical (active) area (cm^2)

Substituting MDCR = $60 \cdot s_i/i$ (MARSSIM Equation 6-9), $t = i$, $s_i = d' \cdot (b_i)^{1/2}$ (MARSSIM Equation 6-8) and $\varepsilon_{T,\beta} = \varepsilon_{i,\beta} \cdot \varepsilon_{s,\beta}$ yields **Equation 4-6**:

Equation 4-6

$$\beta\ scan\ MDC\ (dpm/100\ cm^2) = \frac{60\cdot s_i/t}{\sqrt{p}\cdot\varepsilon_{T,\beta}\cdot\frac{A}{100\ cm^2}} = \frac{60\cdot d'\cdot\sqrt{b_i}/t}{\sqrt{p}\cdot\varepsilon_{T,\beta}\cdot\frac{A}{100\ cm^2}}$$

Where: s_i = minimum detectable net source counts in *t*
d' = index of sensitivity (for error rates α and β)
b_i = background counts in *t*
d = width of detector in direction of scan (cm)
v = average scan rate (cm/s)
$\varepsilon_{T,\beta}$ = detector total (4-π) beta efficiency (counts per disintegration)

Substituting $b_i = R_{B,\beta}$ (cpm) · t (seconds)/60 yields **Equation 4-7**:

Equation 4-7

$$\beta\ scan\ MDC\ (dpm/100\ cm^2) = \frac{d'\cdot\sqrt{R_{B,\beta}\cdot\frac{t}{60}}\cdot\frac{60}{t}}{\sqrt{p}\cdot\varepsilon_{T,\beta}\cdot\frac{A}{100}}$$

Where: $R_{B,\beta}$ = background beta count rate (cpm)

The beta scan MDCs for each scan survey instrument and ROC are presented in **Table 4-8** for various detector average scan rates.

Example: *Beta Scam MDC Calculation for the Ludlum 43-37~~RSCS SCM~~.*

The β scan MDC is calculated for the Ludlum 43-37~~RSCS SCM~~ scanning for beta emitters at 5 cm/s and using the parameters presented in Table 4-5 and Table 4-6. ~~Because the scan rate is motor-controlled and there are no scanning pauses, the surveyor efficiency, p, is 100 percent.~~

$$\beta\ scan\ MDC\ \left(\frac{dpm}{100}cm^2\right) = \frac{3.28 \cdot \sqrt{6361050 \cdot \frac{4.02.67}{60} \cdot \frac{60}{4.02.67}}}{\sqrt{1.0} \cdot 0.9400 \cdot \frac{100}{100}} = 356.0305\ dpm/100\ cm^2$$

Where:
- d' = 3.28 (for 95% true positive and 5% false positive)
- $R_{B,\beta}$ = 636 cpm
- t = d/v = 2013.335 cm/(5 cm/s) = 2.6674 seconds
- p = 1 (assumes automated data logging)
- $\varepsilon_{T,\beta}$ = 0.900 for beta emitters
- A = 100 cm^2

Table 4-8: Beta Scan Minimum Detectable Concentrations (dpm/100 cm^2) at 5 cm/s

Scan Rate (5 cm/s)		
ROC	~~RSCS SCM~~	Ludlum Model 43-37
^{137}Cs	~~356~~	610
^{226}Ra	~~297~~	509
^{90}Sr	~~478~~	305

Notes:
NA = not applicable

Table 4-8 demonstrates that at a scan rate for the Ludlum 43-37RCSC SCM of 5 cm/s, the beta scan MDCs for all ROCs are below the most restrictive RGβ (1,000 dpm/100 cm^2 for ^{90}Sr) for both large area survey instruments. Beta scan MDCs and associated scan speeds will be updated as needed during survey preparation (**Section 4.6.3.1**) to reflect instrument-, ROC-, and surface material-specific information.

4.5.8.6 Static Investigation Levels

Static measurement data will be compared to static ILs. Static measurement data that exceed an applicable static IL will be investigated using biased measurements (**Section 4.6.3.4**).

The alpha and beta static ILs are determined using the static measurement count time in **Equation 4-8**, which is based on the discussion of data conversion in MARSSIM Section 6.6.1. Static ILs will be updated as needed during survey preparation (**Section 4.6.3.1**) using instrument-, ROC- and surface material-specific information.

Equation 4-8

$$\text{Static IL}_{(\alpha\text{ or }\beta)}\ \text{(counts)} = \left[RG_{(\alpha\ or\ \beta)} \cdot \varepsilon_{T(\alpha\ or\ \beta)} \cdot \left(\frac{A}{100\ cm^2}\right) + R_{B(\alpha\ or\ \beta)}\right] \cdot T_{S+B}$$

Where: $RG_{(a\ or\ b)}$ = remediation goal for alpha- or beta-emitting ROC (dpm/100 cm^2)
$\varepsilon_{T\ (a\ or\ b)}$ = detector total (4-π) efficiency (counts per disintegration)
A = detector probe physical (active) area (cm^2)
$R_{B\ (a\ or\ b)}$ = alpha or beta background count rate (cpm)
T_{S+B} = SU static counting time (minutes)

For illustration, the following example calculates the alpha static IL equivalent to the ^{226}Ra RG for the Ludlum Model 43-93, on concrete, using a 1-minute static count time.

***Example**: ^{226}Ra alpha static IL for the Ludlum 43-93.*

$$Static\ IL_{\alpha}(\text{Ludlum Model 43-93}, {}^{226}Ra) = (100 \cdot 0.640 \cdot \left(\frac{100}{100}\right) + 1) \cdot 1 = 65\ counts$$

Where: $RG^{226}Ra_{,\alpha}$ = 100 dpm/100 cm^2
$\varepsilon_{T,\alpha}$ = 0.640 (total weighted alpha efficiency for ^{226}Ra, from **Table 4-6**)
A = 100 cm^2
$R_{B,\alpha}$ = 1 cpm
T_{s+B} = 1 minute

4.5.8.7 Alpha Static Minimum Detectable Concentration

Simultaneous static alpha-beta (paired) measurements typically are taken with alpha-beta detectors coupled to scaler and ratemeter data loggers, and operated in scaler mode for the counting time, T. The division of counting times between background counting time, T_B, and SU counting time, T_{S+B}, is optimized such that the static MDCs will be less than or equal to the RG_a for the building from **Table 4-3**. The static MDC is the a priori net activity concentration above the critical level that is expected to be detected 95 percent of the time. When the count times for the background and SU measurements are different, the static MDC, for either alpha or beta activity, is calculated using **Equation 4-9** (adapted from Strom and Stansbury, 1992). Any areas of elevated activity are assumed to be 100 cm^2 in size. MDC calculations for static measurements will be updated during survey preparations (**Section 4.6.3.1**) using instrument-, ROC-, and surface material-specific information.

Equation 4-9

$$\text{Static MDC (dpm/100 cm}^2) = \frac{[3 + 3.29\sqrt{R_B \cdot T_{S+B} \cdot \left(1 + \frac{T_{S+B}}{T_B}\right)}]}{\varepsilon_T \cdot \frac{A}{100} \cdot T_{S+B}}$$

Where:

R_B = background count rate (cpm)
T_{S+B} = SU counting time (minutes)
T_B = background counting time (minutes)
ε_T = detector total (4-π) efficiency (counts per disintegration)
A = detector probe physical (active) area (cm^2)

Instruments used for static measurements will be selected to ensure that their alpha static MDC is less than or equal to the RG_a for the building from **Table 4-3.**

***Example**: Alpha Static MDC Calculation for the Ludlum Model 43-93.*

The α static MDC is calculated for the Ludlum Model 43-93 using the parameters presented in **Table 4-5** and **Table 4-6**. Using **Equation 4-9**, the calculated α static MDC for ^{239}Pu is 30.8 dpm/100 cm^2.

$$\alpha\ \text{Static MDC}\left(43\text{-}93,\ ^{239}\text{Pu}\right) = \frac{\left[3 + 3.29\sqrt{2 \cdot 2 \cdot \left(1 + \frac{2}{2}\right)}\right]}{0.20 \cdot \frac{100}{100} \cdot 2} = 30.8\ \text{dpm}/100\ \text{cm}^2$$

Where: $R_{B,a}$ = 2 cpm
T_{S+B} = 2 minutes
T_B = 2 minutes
$\varepsilon_{T,a}$ = 0.20
A = 100 cm^2

4.5.8.8 Beta Static Minimum Detectable Concentration

Beta static MDC calculations are also performed using **Equation 4-9** and information from **Table 4-5** and **Table 4-6**. Instruments used for static measurements will be selected to ensure that their beta static MDC is less than or equal to the RG_b for the building from **Table 4-3.** MDC calculations for static measurements will be updated during survey preparations (**Section 4.6.3.1**) using instrument-, ROC-, and surface material-specific information.

The alpha and beta static MDCs for each survey instrument and ROC are presented in **Table 4-9** for 1-minute measurements in the SUs and RBAs.

Table 4-9: Instrument Static Minimum Detectable Concentrations

ROC	Ludlum Model 43-68 (dpm/100 cm^2)		Ludlum Model 43-93 (dpm/100 cm^2)		Ludlum Model 3030 (dpm/100 cm^2)	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
^{137}Cs	NA	178.7	NA	225.1	NA	90.6
^{239}Pu	27.9	NA	30.8	NA	23.5	NA
^{226}Ra	27.9	148.9	30.8	187.6	7.67	84.2
^{90}Sr	NA	178.7	NA	225.1	NA	47.8

Notes:
SU measurement count time = 1 minute; background static measurement count times = 2 minutes; increasing the measurement count time to 2 minutes will lower the example MDCs.
N/A = not applicable.

4.6 Radiological Investigation Implementation

Investigations generally will be implemented in the following order of activities: pre-mobilization/ mobilization, surveys, additional investigations, and demobilization.

4.6.1 Pre-mobilization Activities

Before the start of survey activities, a walkthrough of Parcel B buildings will be completed to accomplish the following:

- Establish building access points and assess security requirements.
- Assess survey support needs such as power, lighting, ladders, and/or scaffolding.
- Verify the types of materials in each SU.
- Identify safety concerns and inaccessible or difficult-to-survey areas.
- Identify radiological protection and control requirements.
- Identify materials requiring removal or disposal, and areas requiring cleaning.
- Assess methods for marking survey scan lanes and static measurement locations.

Impacted areas that are deemed unsafe for access or surveys, if any, will be posted, secured, and annotated in reports.

4.6.1.1 Training Requirements

Any required non-site-specific training required for field personnel will be provided before mobilization to the extent practical. Training requirements are outlined in **Section 6.0**.

Medical examinations, medical monitoring, and training will be conducted in accordance with the APP/SSHP and **Section 6.0** requirements.

In addition to health and safety-related training, other training, including but not limited to the following, may be required:

- Aerial Lift (for personnel working from aerial lifts)
- Fall Protection (for personnel working at heights greater than 5 feet)
- Equipment as required (e.g., fork lift, skid steer, loader, back hoe, excavator)

4.6.1.2 Permitting and Notification

Before field activities for the radiological investigations begin, Gilbane will notify the Navy RPM, ROICC, CSO, and HPNS security as to the nature of the anticipated work. Any required permits to conduct the fieldwork will be obtained before mobilization.

Gilbane will notify CDPH at least 14 days before initiation of activities involving its State of California Radioactive Material License.

4.6.1.3 Pre-Construction Meeting

A pre-construction meeting will be held before mobilization of equipment and personnel. The purpose of the meeting will be to discuss project-specific topics, the roles and responsibilities of project personnel, the project schedule, health and safety concerns, and other topics that require discussions before field mobilization. Representatives of the following will attend the pre-construction meeting:

- Navy (RPM, ROICC, and others as applicable)
- Gilbane (Project Manager, Project QC Manager, PRSO, and SSHO)
- Subcontractors as appropriate

4.6.2 Mobilization Activities

Mobilization activities will include site preparation, movement of equipment and materials to the site, and orientation and training of field personnel.

At least 2 weeks before mobilization, the appropriate Navy personnel, including the Navy RPM, ROICC, and CSO, will be notified regarding the planned schedule for mobilization and site remediation activities. Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials will be mobilized to the site.

The temporary facilities will include restrooms, hand-washing stations, and one or more secure storage (Conex) boxes for short- and long-term storage of materials, if needed.

The applicable AHAs will be reviewed before work begins.

All equipment mobilized to the site will undergo baseline radioactivity surveys in accordance with **Section 6.0**. Surveys will include scan measurements, static measurements, and swipe samples. Equipment that fails baseline surveying will be removed from site immediately.

Loose, residual debris from past building occupation, investigations, vandalism, or asbestos and lead abatement will be removed for disposal and to prepare the buildings for cleaning. Cleaning will be sufficient to remove loose surface material that may not be native to the building construction and may inhibit or damage survey instruments. Cleaning activities will be conducted consistent with the radiation protection procedures in **Section 6.4**. Dust control methods and air monitoring will be implemented, if warranted, as detailed in **Section 8.5**. Floors will be cleaned using ride-on floor scrubbers and vacuums. Walls and other surfaces will be cleaned as required during surveying. Wet areas will be dried using vacuums, blowers, or squeegees and may be delineated with spill containment booms if water infiltration is recurrent. Waste from debris removal and cleaning activities will be evaluated as described in **Section 6.4** and **Section 7.0**.

~~If the building interior is unpaved and the previously-surveyed floor is beneath a durable cover comprising two feet of soil, the overburden soil will be removed to provide site access or otherwise accommodate project activities. Excavated soil will be handled, surveyed, and sampled as described in Section 3.6.3.2. Following backfill of the trenches the area will be restored in accordance with Section 3.6.7.~~

4.6.3 Building Investigation and Remediation Activities

Once all site preparation activities are completed, building investigation activities and remediation (as directed by the Navy) will commence in the following general sequence:

- Mark SUs.
- Prepare instruments.
- Perform alpha-beta scan measurements in SUs and RBAs and conduct preliminary data review.
- Perform alpha-beta systematic static and swipe measurements in SUs and conduct preliminary data review.
- Perform alpha-beta biased static measurements and collect biased swipe samples in SUs and conduct preliminary data review.
- Delineate and remediate residual contamination, if present.
- Evaluate and report data as described in **Section 5.0**.

4.6.3.1 Survey Unit Preparation

SUs will be durably marked prior to measurement activities to indicate SU boundaries, numbers, scan lanes and directions, and systematic measurement locations. Scan lane widths will be approximately 10 percent smaller than the detector's active width, in the direction of scanning, to ensure overlapping coverage.

Upon receipt of survey instruments for the building investigations and completion of performance checks, background measurements will be obtained in the RBAs for each instrument and on each surface material type (e.g., concrete, metal, wood, and sheet rock) that is present in the SUs. The background measurements will consist of at least 18 static measurements on each surface to match the number performed in each SU. The mean instrument- and material-specific background count rates will be used to update the instrument detection calculations and static count times in **Section 4.5.8**.

4.6.3.2 Survey Unit and Reference Background Area Alpha-Beta Scanning

Survey units will be scanned to detect alpha and beta emitters using average scan rates that ensure an alpha probability of detection of approximately 90 percent (**Section 4.5.8.3** and **Section 4.5.8.4**) where feasible and that the beta scan MDC (**Section 4.5.8.5**) is less than or equal to the RG_β for the building (**Section 4.3**). Scanning will cover a total area of each SU according to its classification. The total surface area of remaining, accessible impacted surfaces to be scanned will be 100 percent in Class 1 SUs, 50 percent in Class 2 SUs, and up to 10 percent in Class 3 SUs.

~~The scan rate for the RSCS SCM is entered using the SIMS and results in a fixed, motor-controlled scan rate. At least every 10 SUs of scanning, the RSCS SCM scan rate will be verified manually using the distance scanned and scan duration. The distance scanned is the linear distance, in centimeters, traveled by the detector during data acquisition. The scan duration is the total time, in seconds, of data acquisition. Dividing the distance scanned (cm) by the scan duration (seconds) gives an estimate of~~

~~the average detector scan rate (cm/s) for that scanning period. Direct observation or review of the positional data from the RSCS SCM serve to verify that the detector was in constant motion during scanning.~~ The scan rates for ~~other~~ planned instruments (e.g., Ludlum Model 43-37 and Ludlum Model 43-68) are manually controlled by the surveyor and will be verified manually in each SU by direct observation and measurement of the time elapsed while scanning a known distance. Lanes of approximately 1 meter in width will be marked out within each SU. Lane width may be adjusted as necessary to ensure 100 percent scan coverage. The technician(s) performing the survey will make a note of what corner of the SU the survey will start from (northeast, southwest, etc.), and the direction of travel within each lane. During the survey, the technician will record the observed count rate approximately once every meter while surveying within the designated lane. Survey lanes shall be identified by the use of survey pin flags, cones, or other similar markers.

~~While using a PSPC, scanning may traverse multiple SUs at once for efficiency, but alpha-beta scan data will be assigned to, and analyzed by, individual SUs.~~ Areas ~~inaccessible to a PSPC~~ will be scanned using a gas-proportional detector with data logging functions. A DQA of the alpha-beta scan data (**Section 5.2**) will identify locations that exceed the applicable beta scan IL (**Section 4.5.8.2**) and, therefore, require further investigation (**Section 5.3**). Alpha-beta scan data will also be used to verify the assumptions for the relative shift and revise the number of static measurements for each SU, if necessary (**Section 4.4.1**).

4.6.3.3 Survey Unit Systematic Alpha-Beta Static Measurements

Static measurements will be performed at each systematic static location and will total 18 or more in each SU and the RBA, or the revised number determined in **Section 4.4.1**. Measurements in locations that pose safety concerns or obstructions will be relocated to the nearest safe and accessible location and noted on the field forms.

Each static measurement will be performed in scaler mode for a count duration sufficient to ensure that the alpha and beta static MDCs are equal to or less than the RG_a and RG_b for the building, respectively. Variation in surface types are accommodated by utilizing standard surface efficiency values included in the International Organization for Standardization (ISO) guidance document for evaluation of surface contamination (ISO, 1988). A DQA of the static measurement data (**Section 5.2**) will identify locations that exceed the applicable alpha or beta static IL (**Section 4.5.8.6**) and, therefore, require further investigation (**Section 5.3**) or remediation as directed by the Navy.

4.6.3.4 Biased Alpha-Beta Static Measurements

Biased static measurements will be used to further investigate areas with potentially elevated surface activity, as indicated by systematic static data exceeding the applicable alpha or beta static IL. The survey meter will be operated in scaler mode and measurements will be made for the same count duration as that for the systematic static measurements.

4.6.3.5 Alpha-Beta Swipe Samples

Swipe samples will be taken at all locations of systematic and biased static measurements. They will be taken dry, using moderate pressure, over an area of approximately 100 cm^2. Swipe samples will be analyzed for gross alpha and beta activity using a Ludlum Model 3030 (or equivalent). The surface activity on the sample will be compared to the total surface activity measured by the static measurement to assess the removable fraction of surface activity. The information will be used in any dose or risk assessment performed.

4.6.3.6 Assessment of Residual Materials and Equipment

Any residual materials and equipment from past operations, such as piping, ventilation, shelving, or machinery will undergo radioactivity surveys in accordance with SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**). These surveys may include a combination of static measurements, swipe samples, and material samples. Where possible, sampling or survey points accessed during previous surveys will be used as a starting point. Surveys of impacted building material and equipment will be incorporated into the building SU. After data evaluation, disposition decisions and subsequent investigation of the surfaces below the materials and equipment will be coordinated with the Navy.

4.6.3.7 Decontamination and Release of Equipment and Tools

If radioactive materials above RGs are encountered, decontamination of mobilized materials and equipment may be necessary at completion of fieldwork. Numerous decontamination methods are available for use. If practical, manual decontamination methods will be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be accomplished by using detergents for non-porous surfaces with contamination present. Chemicals selected for decontamination should be those that will minimize the creation of mixed waste. Decontamination activities will be conducted in accordance with SOP PR-RP-132, *Radiation and Contamination Control* (**Appendix C**).

4.6.3.8 Remediation of Contaminated Building Surfaces

Following the identification and characterization of contaminated building surfaces, remediation may be required so that residual radioactivity meets the Parcel B ROD RAO. Specific remediation or decontamination techniques selected will depend on contaminant, type of surface, and other site-specific factors. Types of decontamination that may be performed include concrete scarifying or scabbling, application of strippable surface coatings, and bulk removal of building components. Remediation will be conducted in building areas that exceed RGs or background, whichever is higher. Confirmation measurements will be collected where remediation is performed to verify that contamination has been removed.

4.6.4 Demobilization

Demobilization will consist of surveying, decontaminating, and removing equipment and materials used during the investigations; cleaning the project site; inspecting the site; and removing temporary facilities. Survey of equipment and materials will be performed in accordance with **Section 6.6**, and decontamination will be performed in accordance with **Section 4.6.3.7**. Demobilization activities also will involve collection and disposal of contaminated materials, including decontamination water and disposable equipment for which decontamination is inappropriate (**Section 7.0**).

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5.0 Data Evaluation and Reporting

Data from the radiological investigation will be evaluated to determine whether site conditions are compliant with the Parcel B ROD RAO. If the residual ROC concentrations are below the RGs in the Parcel B ROD (Navy, 2009) or are shown to be NORM or anthropogenic background, then the site conditions are compliant with the Parcel B ROD RAO.

Radiological surveys will include scan measurements of accessible surfaces combined with collection and analysis of samples, and static measurements on building interior surfaces. Scan measurements are used to identify potential areas of elevated radioactivity for investigation using biased samples and static measurements and are not used to directly demonstrate compliance with the Parcel B ROD RAO. Sample and static measurement results at systematic, random, and biased locations are used to evaluate compliance with the Parcel B ROD RAO. A separate compliance decision will be made for each ROC for each sample and static measurement.

In general, the following actions will occur during data evaluation and reporting:

- Scan data will be evaluated to identify potential areas of elevated activity for additional investigation, as follows:
- – Confirm that required scan surveys have been performed on accessible surfaces as described in **Section 3.0** for soil and **Section 4.0** for buildings.
- – Scan data will be verified as described in the SAP (**Appendix A**).
- – DQA will be performed on scan data as described in **Section 5.2**.
- – Potential areas of elevated activity will be identified as described in **Section 5.3.1**.
- – Potential areas of elevated activity will be investigated as described in **Section 5.3.2**.
- Soil sample and static measurement data will be evaluated to determine whether site conditions comply with the Parcel B ROD RAO, as follows:
  - Confirm that required soil samples have been collected from systematic and biased locations as described in **Section 3.0** and that required building measurements have been performed as described in **Section 4.0**.
  - Confirm that samples have been submitted to the laboratory and back-up samples (if any) have been archived in a secure area under chain-of-custody protocols.
  - Confirm that laboratory analyses have been performed as described in the SAP (**Appendix A**).
  - All analytical data will be validated by an independent third party.
  - DQA will be performed as described in **Section 5.2**.

- Sample and direct measurement results will be compared to the corresponding RGs as described in **Section 5.4**.
- Sample and direct measurement results will be compared to the appropriate RBA data from HPNS as described in **Section 5.5**.
- Samples with gamma spectroscopy results that exceed the RG and the expected range of background for ^{226}Ra will be analyzed by alpha spectroscopy for uranium isotopes (specifically ^{238}U~~, ^{235}U,~~ and ^{234}U), thorium isotopes (specifically~~^{232}Th,~~ ^{230}Th~~, and ^{228}Th~~), and ^{226}Ra to evaluate the equilibrium status of the uranium natural decay series to determine whether ^{226}Ra is NORM as described in **Section 5.6**.

• Results of the investigation will be documented as described in **Section 5.7**.

5.1 Data Quality Validation

Analytical data validation will be performed by an independent third party as described in the SAP (**Appendix A**). Data validation will be performed on all TU/SU data and all RBA data.

5.2 Data Quality Assessment

The DQA is a scientific and statistical evaluation that determines whether the survey data are the right type, quantity, and quality to support the survey objectives (USEPA, 2006). There are five steps in the DQA process:

1. Review the DQOs and survey design.
2. Conduct a preliminary data review.
3. Select the statistical test.
4. Verify the assumptions of the statistical test.
5. Draw conclusions from the data.

The effort expended during the DQA should be consistent with the graded approach used to develop the survey design. The DQA process will be applied to all SU data and all RBA data.

5.2.1 Review the Data Quality Objectives and Survey Design

The sampling design and data collection documentation will be reviewed for consistency with the DQOs. At a minimum, this review will include:

- Number of soil samples or measurements in each SU
- Location of soil samples and measurements
- Measurement technique (i.e., scan, static, or sample) and instrumentation
  - Measurement uncertainty
  - Detectability (critical level and MDC)
  - Quantifiability

- Statistical power

The review will focus on identifying the information required to complete the evaluation of the data. Whether the survey objectives were achieved will be determined during Step 5 of the DQA Process (see **Section 5.2.3**).

5.2.2 Conduct a Preliminary Data Review

A preliminary data review will be conducted to learn about the structure of the data by identifying patterns, relationships, and/or potential anomalies. The preliminary data review will include calculating statistical quantities, preparing posting plots of scan and sample data, preparing histograms of scan and sample data, preparing quantile-to-quantile (Q-Q) plots (sometimes referred to as normal probability plots) of scan and sample data, preparing box plots of scan and sample data, preparing retrospective power curves, and analyzing data distributions.

If additional data evaluation tools are used to support conclusions concerning compliance with the Parcel B ROD RAO, the report will provide a complete description of the evaluation performed and any assumptions used. For example, if a contour plot is provided to describe site conditions, the report will contain a description of the contouring technique used, a list of parameter values and assumptions used to prepare the contour plots, a copy of the contour plot, and an interpretation of the contour plot relative to compliance with the Parcel B ROD RAO.

5.2.2.1 Convert Survey Results

The RGs for soil (**Table 3-5**) are stated in units of pCi/g, and soil sample results from the analytical laboratory will be reported in units of pCi/g, so no conversion will be necessary for soil sample data.

The RGs for buildings surfaces (**Tables 4-2 and 4-3**) are stated in units of dpm/100 cm^2; however, alpha and beta static measurement results will be reported in units of counts during a specified counting interval, while scan results will be reported in units of counts per second (cps) or cpm. Example ILs for alpha and beta scan measurements are provided in **Table 4-7** where the RGs have been converted into cpm using **Equation 4-2** and example total efficiencies from **Table 4-6**. Example ILs for alpha and beta static measurements are provided in **Table 4-9** where the RGs have been converted into counts using Equation 4-8 and example total efficiencies from **Table 4-6**. Instrument-specific total efficiencies and material-specific backgrounds will be determined in the field, along with instrument-specific ILs corresponding to the RGs for alpha and beta static measurements on building surfaces.

Once all the survey results and RGs are available in the same or comparable units, the evaluation of the data can continue.

5.2.2.2 Calculate Statistical Quantities

The mean, median, standard deviation, minimum, and maximum for each data set will be reported. Other statistical quantities that may be reported to describe individual data sets include percentiles (25th and 75th for interquartile range, 95th and 99th for upper bound estimates), skewness (a measure of deviation from normal), coefficient of variation, and total number of data points in the data set.

5.2.2.3 Prepare Posting Plots

Posting plots are maps on which measurement results are shown at the location where the measurement was performed. Posting plots will be prepared for scan, static measurement, and sample data from biased, systematic, and random locations on building surfaces. Posting plots of soil sample locations may also be prepared for Phase 1 TUs, Phase 2 TUs, and surface soil SUs. Posting plots will be prepared for each SU but are not required for each RBA.

Posting plots will be inspected to identify patterns or inconsistencies in the data, especially potential areas of elevated activity requiring additional investigation or spatial trends identifying survey data that are not independent, violating the assumptions of the statistical tests. Posting plots may be prepared using counts, count rates, concentrations, or normalized data (standard deviations or z-scores) allowing comparison of results from multiple detectors or different measurement methods. Posting plots are most useful when presented in the same units as the RGs or ILs being evaluated.

5.2.2.4 Prepare Histograms

Histograms, or frequency plots, are used to examine the general shape of a data distribution. Histograms will be prepared for scan, static measurement, and swipe sample data from systematic and random locations, and for soil sample data from systematic locations for each SU and RBA. Biased survey data do not need to be included when preparing histograms; however, care should be taken when interpreting histograms that include data collected from biased locations. Histograms reveal obvious departures from symmetry, including skewness, bimodality, or significant outliers.

5.2.2.5 Prepare Q-Q Plots

Q-Q plots compare a data distribution to an assumed normal distribution. Q-Q plots will be prepared for scan, static measurement, and swipe sample data from systematic and random locations, and for soil sample data from systematic locations for each SU and RBA. Biased survey data do not need to be included when preparing Q-Q plots; however, care should be taken when interpreting Q-Q plots that include data collected from biased locations.

Background data usually approximate a normal distribution, so comparing SU data to a normal distribution is one technique in comparing survey data to background. Data from a normal distribution appear as a straight line on a Q-Q plot, so deviations from a straight line indicate potential deviations from a normal distribution, or potential deviations from background. Normal probability plots from different data sets, such as a SU and an RBA or adjacent SUs, can be shown on the same graph to allow for direct comparisons between multiple data sets.

5.2.2.6 Prepare Box Plots

Box plots are a non-parametric graphical depiction of numerical data based primarily on quartiles (25th, 50th, and 75th percentiles). Box plots may include whiskers showing extreme values, usually the minimum and maximum. Box plots also may show outliers as individual points. The ends of the whiskers and selection criteria for outliers are not standardized, and may represent different values depending on the underlying assumptions.

Box plots provide visual estimates of dispersion and skewness for a data set including the range, interquartile range, and median. Box plots from different data sets, such as an SU and an RBA or adjacent SUs, can be shown on the same graph to allow for direct comparisons between multiple data sets.

5.2.2.7 Prepare Retrospective Power Curves

A retrospective power curve provides an evaluation of the survey design and is used to demonstrate that enough data were collected to support decisions regarding the radiological status of the SU. Retrospective power curves will be prepared for static measurements and swipe sample data from systematic and random locations, and for soil sample data from systematic locations for each SU. Biased survey data will not be included when preparing retrospective power curves. The retrospective power curve is compared with the DQOs (**Section 3.1** and **Section 4.1**) to evaluate whether a sufficient number of samples was collected.

No statistical tests are required for individual data sets because compliance with the Parcel B ROD RAO is based on point-by-point comparisons. Because the number of measurements per SU was determined assuming that a statistical test would be performed, the retrospective power curve assists in determining whether the survey design was adequate, but is not directly related to compliance decisions.

5.2.2.8 Analysis of Data Distributions

The distribution of data within a data set can provide important information during data evaluation. Determining the type of distribution may be important for selecting additional evaluation tools to answer specific questions about individual data sets.

Environmental data are most often associated with three distributions: normal, lognormal, or gamma. Statistical tests to identify a distribution have a null hypothesis that the data set comes from the distribution being tested. This means there must be sufficient evidence showing that the data do not follow a specific distribution before the initial assumption is rejected. For this reason, it is not unusual for a data set to be associated with more than one type of distribution. Moreover, negative values in a data set cannot provide results for analyzing lognormal or gamma distributions.

Individual data sets will be analyzed to determine whether the data appear to follow a normal, lognormal, or gamma distribution at a 5 percent significance level using software such as ProUCL. Data sets that do not follow at least one of these distributions will be identified as not following any known distribution and will be evaluated using non-parametric tools and tests.

5.2.3 Draw Conclusions from the Data

Figure 3-2 and **Figure 4-129** present an overview of how decisions for soil and building data, respectively, will be combined to draw a conclusion on compliance with the Parcel B ROD RAO. Each sample and static measurement result will be compared to the corresponding RG. If all residual ROC concentrations are less than or equal to the corresponding RG, then site conditions comply with the Parcel B ROD RAO.

Sample and measurement data will be compared to appropriate RBA data from HPNS, and multiple lines of evidence will be evaluated to determine whether site conditions are consistent with NORM or anthropogenic background. The data evaluation may include population-to-population comparisons, use of a MLE or BTV, graphical comparisons, and/or comparison with regional background levels. If all residual ROC concentrations are determined to be consistent with NORM or anthropogenic background, site conditions comply with the Parcel B ROD RAO.

Each ^{226}Ra gamma spectroscopy result exceeding the ^{226}Ra RG and outside the expected range of background will be compared to concentrations of other radionuclides in the uranium natural decay series from the same sample. If the concentrations of radionuclides in the uranium natural decay series are consistent with the assumption of secular equilibrium, then the ^{226}Ra concentration is NORM, and site conditions comply with the Parcel B ROD RAO.

If the investigation results demonstrate that there are no exceedances determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels, or that residual ROC concentrations are NORM or anthropogenic background, then a RACR will be developed.

If the investigation results demonstrate exceedances of the RGs determined from a point-by-point comparison with the RGs at agreed upon statistical confidence levels and are not shown to be NORM or anthropogenic background, remediation will be conducted, followed by the preparation of a RACR. The RACR will describe the results of the investigation, explain remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel B ROD RAO through the use of multiple lines of evidence including application of statistical testing with agreed upon statistical confidence levels on the background data.

5.3 Investigation of Potential Areas of Elevated Activity

The investigation of potential areas of elevated activity consists of comparing each measurement result from every SU with the ILs discussed in **Section 3.3.1** for soil, **Section 4.5.8.2** for building scans, and **Section 4.5.8.2** for building static measurements. In general, the ILs are consistent with the RG values. This investigation is performed for all measurement results: scans, static measurements, and samples, at systematic, random, and biased locations. The investigation of potential areas of elevated activity ensures that unusually high measurement and sample results will receive proper attention, and that any area having the potential for significant contributions to total dose will be identified.

5.3.1 Identify Potential Areas of Elevated Activity

Scan, static measurement, and sample data will be evaluated to identify statistical and spatial anomalies indicating potential areas of elevated activity. Scan data will be compared directly to RGs or ILs. Posting plots will be used to identify trends and patterns in the scan data to help in identifying potential areas of elevated activity and support defining the areal extent of potential areas of elevated activity. Histograms and Q-Q plots will be used to identify significant outliers and evidence of multiple distributions to identify potential areas of elevated activity. Any sample or measurement exceeding a ROC-specific RG will be investigated as a potential area of elevated activity. In addition, SU areas with multiple lines of evidence indicating a potential increase in localized activity based on posting plots, histograms, and Q-Q plots of scan, static measurement, or sample data will be investigated as a potential area of elevated activity.

If direct measurement or sample results exceed the RG or IL for a specific ROC for locations not identified by scan survey, the scan survey technique will be reviewed and investigated to determine whether the scan survey was implemented correctly and whether the scan methodology met the survey objectives.

5.3.2 Investigate Potential Areas of Elevated Activity

The objective of investigating potential areas of elevated activity is to characterize the ROCs present and the size, or extent, of all areas of elevated activity. To accomplish this objective, a minimum of one potential area of elevated activity will be investigated in every TU/SU. If no potential areas of elevated activity are identified in a TU/SU based on **Section 5.3.1**, the location of the maximum scan, static measurement, or sample result will be identified as a potential area of elevated activity.

The first step in investigating potential areas of elevated activity is to confirm the measurement or sample results that indicated the potential area of elevated activity. For alpha and beta scans, this may be accomplished by pausing during scanning to collect additional information, or it may require returning to a location to perform a biased static measurement. For gamma scan surveys, this may involve rescanning the area surrounding the potential elevated reading, sifting through near surface soil for a discrete source of activity (e.g., deck marker), or collecting a biased soil sample for analysis. The selection of the confirmatory action will depend on the initial results and the decision on whether the original results are confirmed. In general, minimal information is acceptable when deciding to continue with the investigation of a potential area of elevated activity. In most cases, at least one measurement or sample result documenting the lack of elevated activity will be required to support a decision to terminate the investigation of a potential area of elevated activity.

Once the presence of an area of elevated activity has been confirmed, the ROCs present will be identified. In most cases the identification of ROCs can be accomplished using existing data. For building surfaces, it is sufficient to identify the elevated activity as alpha, beta, or a combination of alpha and beta radiation. For soil samples, it is generally necessary to identify the radionuclide based on laboratory analysis.

The final step in investigating areas of confirmed elevated activity is determining the area, or extent, of the elevated results. The identification of the ROCs present will assist in determining whether additional data are required to determine the extent of elevated activity, and the number and type of measurements or samples that will be used for that determination. For building surfaces, the posting plot of the scan data is generally all that is needed to determine the extent of the elevated readings. The determination may be accomplished in the same manner for surface soil SUs when the ROC is ^{226}Ra and the elevated activity is readily detected by gamma scan surveys. Determining the extent of elevated activity for ROCs without a significant gamma emission, such as ^{90}Sr and ^{239}Pu, will require collecting additional soil samples or establishing a correlation between the difficult-to-detect ROC and ^{226}Ra. Even when a correlation can be determined, the gamma scan survey objectives will need to be reviewed and adjusted to account for detecting ^{226}Ra at lower activity levels. If the elevated activity is associated with ^{90}Sr or ^{239}Pu results significantly above background, a Field Change Request will be initiated to document the characterization of any potential areas of elevated activity. The results of the investigation should identify an area of elevated activity bounded by measurements or sample results below the RGs or ILs.

If all alpha or beta static measurement or ROC-specific soil sample analysis results are less than the RGs or ILs, compliance with the Parcel B ROD RAO is achieved.

5.4 Comparison to RG Values

The Parcel B ROD (Navy, 2009) establishes RGs for soil and building surfaces. These RG values are provided in **Table 3-5** for soils and **Table 4-2** and **Table 4-3** for building surfaces.

Analytical data from systematic and biased surface and subsurface soil sample results will be compared directly with the RGs listed in **Table 3-5**. Each soil sample will have gamma spectroscopy data for ^{137}Cs (reported from its 661 keV peak) and ^{226}Ra (reported using the 609 keV gamma emission from ^{214}Bi following a 21-day ingrowth period). Additionally for Building 157, each soil sample will have gamma spectroscopy data for ^{60}Co. For all soil TUs and SUs, 10 percent of samples will be analyzed for ^{90}Sr. In addition, a minimum of 10 percent of randomly selected systematic soil samples will be analyzed by alpha spectroscopy for ^{239}Pu. These analytical results will be compared directly with the RGs listed in **Table 3-5** to determine compliance with the Parcel B ROD RAO.

Cesium-137 is considered to be the indicator for all fission product radionuclides associated with NRDL activities. The limited number of systematic samples analyzed for ^{90}Sr and ^{239}Pu will serve to supplement the investigation. Sample results above the ^{137}Cs RG will trigger additional analyses in the same sample for ^{90}Sr or ^{239}Pu. The results of these additional analyses will be compared directly with the corresponding RG values for ^{137}Cs, ^{90}Sr, and ^{239}Pu. Based on the inability to perform gamma scanning for these radionuclides at the RG, demonstrating compliance with the Parcel B ROD RAO will be based on soil sample analytical results.

The RGs for building surveys are listed in **Table 4-2**. Static measurement results will be provided for total alpha and total beta activity and are not radionuclide-specific. Therefore, the lowest RG values for alpha and beta-emitting ROCs (listed in **Table 4-3**) will be selected. Total alpha and total beta results will be corrected for material-specific background and reported as net activity above the mean activity for that material from the RBA representing background for a specific building, on a specific material, using a specific detector. The net total activity will be compared directly with the corresponding RG.

If all sample and direct measurement results are less than or equal to the corresponding RGs, then the site conditions are compliant with the Parcel B ROD RAO, and a RACR can be prepared as described in **Section 5.7**.

5.5 Comparison to Background

Sample and static measurement data shown to be NORM or anthropogenic background comply with the Parcel B ROD RAO, even if the results exceed the corresponding RG values. The burden of proof will be on the Navy to demonstrate that results above an RG are not site-related. In addition, to address CDPH requirements for radiological release specified in California Code of Regulations (CCR) Title 17, Section 30256, a comparison of site data with background will be performed.

RBA data sets for soil ~~will be~~have been developed ~~as directed~~ by the Navy ~~or selected from existing RBA data sets~~ and will be utilized wherever approved as ~~determined to be~~ representative of soil at HPNS (CH2M Hill, 2019). RBA data sets for building surfaces ~~will be developed as described in Section 4.4.2 to~~ provide building-specific, material-specific, and instrument-specific RBA data~~. Ultimately, RBA data sets will be~~, and have been concurred with by the Navy, USEPA, and the State of California.

The comparison of site data with background may include, but is not limited to:

- **Population-to-population comparisons.** Site data sets may be compared with RBA data using parametric or non-parametric tests, depending on the distributions of the data. Following the performance of any population test, the underlying assumptions of the test will be verified.
- **Use of an MLE or BTV.** A point-by-point comparison of site data with the MLE or BTV may be performed if RBA data allow for calculation of those values. MLE values will be calculated using software such as USEPA's ProUCL.
- **Graphical comparisons.** Graphical representations of site and RBA data may be useful in visually comparing two or more data sets visually. Typical graphical tools include histograms, box-and-whisker plots, and probability plots.
- **Comparison with regional background levels**. As noted in **Section 5.6**, much of HPNS was constructed using fill materials from off-site sources. As such, soil conditions at the site are heterogeneous, and the on-site RBAs may not accurately capture background levels of ROCs for all soil types that may be present at HPNS. Where appropriate, available RBA data from other sources may be used for comparison with site data.

If all residual ROC concentrations are consistent with NORM or anthropogenic background, site conditions comply with the Parcel B ROD RAO. If any ^{226}Ra gamma spectroscopy results for soil exceed the RG and the expected range of NORM concentrations, the equilibrium status of the uranium natural decay series will be evaluated for the sample as described in **Section 5.6**.

5.6 Determine Equilibrium Status

The RBA data set for ^{226}Ra and other naturally occurring ROCs will be selected to represent as much of the soil at HPNS as practical. However, the history of HPNS shows that a wide variety of fill materials were used as part of construction and maintenance activities over the life of the site. These fill materials may have a range of naturally occurring radioactivity, so an incorrect identification of fill material could result in higher levels of NORM being identified as contamination. To avoid this situation, additional evaluation may be performed for samples in which the ^{226}Ra gamma spectroscopy result exceeds the RG and the expected range of background, but the sample could still indicate association with NORM instead of contamination.

The uranium natural decay series is one of the primordial natural decay series collectively referred to as NORM. The members of the uranium natural decay series are present in background at concentrations that are approximately equal, a situation referred to as secular equilibrium. Secular equilibrium for the uranium natural decay series is established over hundreds of thousands of years. Concentrations of ^{226}Ra higher than the concentrations of other members of the uranium natural decay series may indicate contamination, while ^{226}Ra concentrations consistent with other members of the series indicate natural background.

Determining the equilibrium status of the uranium natural decay series requires analyzing a sample for multiple radionuclides from the series using the same or comparable analytical techniques. Observed differences in concentrations result primarily from differences in concentrations, and the uncertainty is primarily associated with the analysis.

Radionuclides from the uranium natural decay series with ^{226}Ra as a decay product (i.e., ^{238}U, ^{234}U, and ^{230}Th) will be analyzed by alpha spectroscopy, along with ^{226}Ra. It is not necessary to analyze for the decay products of ^{226}Ra because these radionuclides re-establish secular equilibrium with ^{226}Ra over a period of several weeks. In addition, most of the ^{226}Ra decay products are not readily analyzed by alpha spectroscopy.

If practical, the analyses will be performed using the same sample aliquot to reduce sampling uncertainty. The results of the four radionuclides will be compared. If the ^{226}Ra result is similar to the results for the other radionuclides, the ^{226}Ra activity is NORM and complies with the Parcel B ROD RAO, and the equilibrium determination will be documented in the RACR. If the ^{226}Ra result is significantly greater than the results for the other radionuclides and exceeds the RG, the elevated ^{226}Ra level may be attributed to site contamination, and remediation may be required as directed by the Navy.

5.7 Reporting

Results of radiological investigations for buildings and TUs/SUs complying with the Parcel B ROD RAO will be documented in a RACR, and the buildings and TUs/SUs will be recommended for unrestricted radiological release. The RACR will describe the results of the investigation, provide visualizations of spatially correlated data, explain any remediation performed, compare the distribution of data from the sites with applicable reference area data, and provide a demonstration that site conditions are compliant with the Parcel B ROD RAO. The final status survey results, including a comparison to background and discussion of remedial activities performed as part of the investigation, will be included as an attachment to the RACR.

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6.0 Radioactive Materials Management and Control

Project requirements, including personnel roles and responsibilities, required training, and health and safety protocols are presented in this section. This section was prepared based on Gilbane leading and conducting the field activities presented in this work plan. **Appendix C** contains Gilbane-specific information, specifically the Radiation Protection Plan and supporting SOPs. A separate APP/SSHP will be prepared to outline the health and safety requirements and procedures for the work included in this work plan.

6.1 Project Roles and Responsibilities

The Gilbane Project Manager is responsible for overseeing all field activities for this project. The Gilbane Project Manager will serve as the primary point of contact for scheduling and field-related issues. The PRSO has overall responsibility for ensuring that fieldwork is conducted by trained staff in accordance with the Radioactive Material License and applicable plans and procedures.

The PRSO will be supported by radiation protection staff to implement the requirements of the license SOPs and for conducting radiological data collection in accordance with **Section 3** and **Section 4** of this work plan.

6.2 Licensing and Jurisdiction

Gilbane possesses current radioactive material licenses from the NRC (License No. 04-29358-01) and the State of California (License No. 7948-07). HPNS exists under split regulatory oversight of radiological activities by the NRC (Region IV) and the State of California (CDPH Radiologic Health Branch). **Figure 6-1** details the approximate jurisdictional boundary. Gilbane understands the complexity of operating under both NRC and State of California licenses, and recognizes that the State of California maintains authority for unrestricted release regardless of jurisdiction. Both the NRC and CDPH have approved Gilbane's radiation safety procedures and incorporated them by reference into Gilbane's radioactive material licenses.

A Memorandum of Understanding (MOU) among radioactive material licensees at HPNS currently exists and will be updated as needed to ensure proper interfacing of radioactive material handling responsibilities.

6.3 Radiological Health and Safety

Fieldwork will be conducted in accordance with Gilbane's radioactive material licenses and associated radiation safety SOPs. The SOPs that provide the instructions for conducting field activities involving exposure to radiation and radioactive materials are provided in **Appendix C**.

Prerequisites for the initiation of survey activities include review of this work plan, radiological evaluation of the designated work areas, and identification of potential safety concerns. Dose rate, contamination, and air monitoring, including initial baseline sampling to determine radiological background conditions, will be performed as necessary and in accordance with this work plan and the supporting procedural documents, including the SOPs in **Appendix C**. Radiation Work Permits (RWPs) will be prepared in accordance with SOP PR-RP-130, *Radiation Work Planning and Control.* RWPs will be used to govern radiological health and safety. Personal protective equipment (PPE) levels will be assigned or modified, according to this work plan and APP/SSHP, and SOP PR-RP-180, *Personnel Protection and Emergency Response,* such that they are protective of health and safety based on radiological considerations and physical and chemical safety issues. Radiological personnel will prepare, approve, and record monitoring records in accordance with SOP PR-RP-190, *Radiological Records, Notifications, and Reports*.

Key radiological personnel are expected to have the requisite skills necessary to perform these functions. The key radiological personnel include:

- Gilbane Project Manager
- PRSO
- Radiation Protection Supervisor
- RCTs

Roles may be combined as described in this work plan. Key personnel will be approved in advance by the project manager or field lead.

6.4 Radiation Protection

Appendix C contains the Radiation Protection Plan, which includes key Gilbane Radiation Protection Program procedures. The Radiation Protection Plan details requirements for activities conducted under Gilbane's radioactive material licenses and describes radiation safety practices to be applied in the field and referenced in the APP/SSHP. The Radiation Protection Plan covers project activities that involve the use or handling of licensed by-product, source, or special nuclear material (hereinafter referred to as radioactive material); tasks with the potential for radioactive material to be present based on available data and historical records; and work in posted RCAs.

6.4.1 Radiological Postings

Radiological postings are used to delineate the RCAs necessary to conduct investigation activities. Radiological posting requirements are found in SOP PR-RP-160, *Radiation and Contamination Control* (**Appendix C**).

6.4.2 Internal and External Exposure Control and Monitoring

Based on a review of historical data, radiation doses are not expected to exceed 100 millirem per year (annual public dose allotment) for any project personnel. Although worker doses are expected to be a small fraction of the annual limits, external dose rates and cumulative doses and internal doses, via airborne concentration measurements, will be monitored to ensure that worker doses are maintained as low as reasonably achievable (ALARA). The dosimetry requirements are contained in SOP PR-RP-120, *Radiation Dose Limits and Personnel Monitoring*. The expectation is that all personnel entering the controlled area except for untrained, escorted individuals as described in **Section 6.4.3** will be assigned an external monitoring device such as a thermoluminescent dosimeter. Untrained, escorted personnel entries will be logged such that the escort thermoluminescent dosimeter badge results can be used as the monitoring results for those individuals if a question arises as to the possible external dose that an individual received. Periodic external dose rate measurements will be taken before and during intrusive activities in accordance with SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**), to ensure that worker exposures are maintained ALARA.

6.4.3 Radiological Access Control

Access control is necessary to provide a consistent methodology for controlling the access of personnel, equipment, and vehicles into radiological areas. Access control points further control the release of the materials, tools, and equipment from radiological areas. Access control requirements are found in SOP PR-RP-160, *Radiation and Contamination Control* (**Appendix C**). It is anticipated that areas targeted for investigation as part of this plan, including the RSYs, will be established as RCAs.

Personnel and equipment exiting the boundary of an RCA will be surveyed to ensure that their clothing, equipment, and vehicles do not leave the site with contamination.

An RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP will provide information to workers on area radiological conditions and entry requirements including PPE. The following summarizes the RWP process for this project:

- RWPs will be prepared by the PRSO or designee.
- RWPs will be approved by the PRSO or designee.
- Expected levels of contamination and external exposure rates will be listed in the RWP.
- Current and expected radiological conditions will be listed in the RWP.
- PPE and monitoring requirements will be specified in the RWP.
- Special monitoring instructions, hold points, or action levels may be listed as a part of the RWP requirements.
- RWP approval duration will be for the expected length of the project or until radiological conditions change and a revision is needed.
- Where radiological conditions change such that PPE or monitoring requirements must change, the work will be suspended until a new or revised RWP containing the new RWP requirements is issued.

- Personnel working in the area covered by the RWP will be briefed on the RWP requirements and sign an acknowledgment that they have received and understand the briefing.

RWP requirements are found in SOP PR-RP-130, *Radiation Work Planning and Control* (**Appendix C**).

6.4.4 Personal Protective Equipment

PPE will be selected based on the specific hazard and will comply with the APP/SSHP, the RWP, and the AHA specific to the task being performed. Based on historical information, the planned investigation activities are not expected to encounter or generate removable or airborne radioactivity. Therefore, it is expected that fieldwork PPE will consist of wearing Level D PPE, which includes:

- Long pants
- High visibility outer layer
- Safety-toed boots
- Hard hat
- Work gloves
- Eye protection

If the field conditions exceed action levels for additional response (detailed in procedures SOP PR-RP-130, *Radiation Work Planning and Control*; SOP PR-RP-160, *Radiation and Contamination Control*; and SOP PR-RP-180, *Personnel Protection and Emergency Response*) (**Appendix C**), PPE may be upgraded as necessary.

6.4.5 Instrumentation

Instruments to be used for worker protection and monitoring will include dose and exposure rate instruments, alpha-beta dual phosphor surface contamination detectors, handheld 2-inch by 2-inch NaI detectors for gross gamma investigations, and a gas-flow proportional or dual phosphor alpha-beta bench-top counter for analysis of surface swipe samples and air samples. Instruments will be operated in accordance with applicable instrument-specific SOPs.

All counting systems and instruments will be calibrated with a National Institute of Standards and Technology-traceable source at intervals not exceeding 12 months, or as recommended by the manufacturer. The source used will be appropriate for the type and the energy of the radiation to be detected. All calibrations will be documented and include the source data.

The minimum training requirements for personnel working in the field at HPNS are provided in the following subsections.

6.4.6 Radiological Training

Radiological training includes the following modules (or equivalent) in accordance with SOP PR-RP-110, *Radiation Safety Program Administration* (**Appendix C**):

- Radiation safety awareness training
- Radiation worker training and certification
- RCT training and certification

Visitors and escorted persons must receive a site briefing and will be assigned to a qualified radiation worker or RCT when in a posted RCA.

6.4.7 Health and Safety Training

Health and safety training may include, but is not limited to:

- Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (Hazardous Waste Operations and Emergency Response [HAZWOPER]) training
- OSHA 8-hour HAZWOPER refresher training
- OSHA 8-hour HAZWOPER supervisor training
- OSHA-required On the Job training
- Site- or task-specific AHA training
- Basic first aid training
- Cardiopulmonary resuscitation training

6.5 Radiological Support Surveys

Personnel, equipment, material, and area surveys will be performed in accordance with this work plan and appendices. If survey results indicate levels of surface contamination, appropriate decontamination methods will be conducted in accordance with the applicable SOPs (**Appendix C**).

6.5.1 Personnel Contamination Monitoring

Personnel contamination monitoring will be conducted in accordance with SOP PR-RP-180, *Personnel Protection and Emergency Response* (**Appendix C**). Personnel contamination monitoring is performed to ensure that individuals leaving an RCA are free of contamination. Hands and feet "frisks" with dual alpha-beta scintillators will be required when individuals exit RCAs.

Personnel contamination monitoring will be performed in the alpha+beta mode of the instrument because of the potential presence of ^{90}Sr, a pure beta emitter, and the fact that there are beta emissions from progeny in the radium decay chain that can be used as a surrogate for potential radium contamination. Where contamination is found or suspected, the PRSO will be contacted and will provide further technical direction for any personnel/clothing decontamination that may be needed.

6.6 Equipment Surveys

6.6.1 Swipe Samples

Swipe sampling will be performed to assess the presence of radioactive contamination that is readily removed from a surface. Swipe samples will be taken to evaluate the presence of removable alpha and beta activity. The procedures for collecting swipe samples are discussed in SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**).

6.6.2 Exposure Rate Surveys (Dose Rates)

Exposure rate surveys are performed to measure ambient gamma radiation levels. Exposure rate surveys will be performed prior to and periodically during intrusive activities to confirm exposure levels relative to RWP requirements.

6.6.3 Equipment Baseline and Unconditional Release Surveys

Equipment mobilized and demobilized from the site will undergo radiological surveys in accordance with SOP PR-RP-150 *Radiological Survey and Sampling* and SOP PR-RP-160 *Radiation and Contamination Control* (**Appendix C**). Baseline and release surveys may include a combination of surface scans and static measurements using dual alpha-beta scintillators and swipe samples.

6.7 Documentation and Records Management

The purpose of this section is to define standards for the maintenance and retention of radiological records. Radiological records provide historical data, document radiological conditions, and record personnel exposure. Field documentation requirements are outlined in the SAP (**Appendix A**) and in SOP PR-RP-190, *Radiological Records, Notifications, and Reports* (**Appendix C**).

Radiological surveys will be performed and documented in accordance with SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**). Sample collection, field measurements, and laboratory data will be recorded electronically to the extent practicable. Electronically recorded data and information will be backed up to a SharePoint site or equivalent on a nightly basis, or as reasonably practical. Data and information recorded on paper will be recorded using indelible ink. Both electronic and paper records of field-generated data will be reviewed by the PRSO or a designee knowledgeable in the measurement method for completeness, consistency, and accuracy. Data manually transposed to paper from electronic data collection devices will be compared to the original data sets to ensure consistency and to resolve noted discrepancies. Electronic copies of original electronic data sets will be preserved on a non-magnetic retrievable data storage device. No data reduction, filtering, or modification will be performed on the original electronic versions of data sets.

6.7.1 Documentation Quality Standards

Records will be legible and completed with an indelible ink that provides reproducible and legible copies. Records will be dated and contain a verifiable signature of the originator. Errors that may be identified will be corrected by marking a single line through the error and by initialing and dating the correction.

Radiological records will not be corrected using an opaque substance. Shorthand or non-standard terms may not be used.

To ensure traceability, each record will clearly indicate:

- Name of the project
- Specific location
- Function and process
- Date
- Document number (if applicable)

The quantities used in records will be clearly indicated in standard units (e.g., curie, roentgen equivalent man [rem], dpm), including multiples and subdivisions of these units.

6.7.2 Laboratory Records

Survey and laboratory data assessment records will be prepared as indicated in Gilbane's Contractor Quality Control Plan (**Appendix B**).

6.7.3 Record Retention

Records resulting from implementation of this work plan will be retained as outlined in the SAP (**Appendix A**).

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7.0 Waste Management Plan

This section describes the type of waste expected to be generated and the management, transport, and disposal of the material.

7.1 Project Waste Descriptions

Waste generated during this investigation may be radiological in nature. It is anticipated that these waste streams will be generated and managed as indicated in **Table 7-1**. The project Environmental Manager (EM) will be consulted for waste streams that are not specifically identified.

Table 7-1: Waste Management

Waste Stream	Source/Process	Staged in	Staged at	Final Disposition
Radiological Wastes (LLRW)				
Soil, ~~or~~ sediment, or vegeation	Soil sampling / building cleaning activities / removal of durable soil cover / clearing and grubbing	In accordance with 40 CFR 173, Subpart I	Navy approved location	Off-site disposal
Concrete and asphalt	Excavation / sampling	In accordance with 40 CFR 173, Subpart I	Navy approved location	Off-site disposal
Potential radiological commodities (e.g., deck markers)	Excavation / sampling	In accordance with 40 CFR 173, Subpart I	Navy approved location	Off-site disposal
Debris including PPE, plastic sheeting, disposable sampling equipment	Investigation activities involving disposable equipment	Include with soil / concrete	Navy approved location	Off-site disposal
Water from decontamination or dewatering	Excavation / sampling / equipment decontamination / building cleaning activities	In accordance with 40 CFR 173, Subpart I	Navy approved location	Off-site disposal
Non-Radiological Wastes (Non-LLRW)				
Soil, sediment, vegetation, concrete, or asphalt	Soil sampling / removal of durable soil cover / clearing and grubbing / building cleaning activities	DOT specification drums or containers, IBC, or roll-off type bins	Navy approved location	Off-site disposal

Table 7-1: Waste Management

Waste Stream	Source/Process	Staged in	Staged at	Final Disposition
Debris including PPE, plastic sheeting, disposable sampling equipment	Investigation activities involving disposable equipment	Include with soil	Navy approved location	Off-site disposal

Table 7-1: Waste Management (continued)

Waste Stream	Source/Process	Staged in	Staged at	Final Disposition
Water from decontamination or dewatering	Excavation / sampling / equipment decontamination / building cleaning activities	DOT specification drums or containers	Navy approved location	Off-site disposal
Miscellaneous trash that has not contacted contaminated media	Investigation activities	Black non-translucent trash bags	Removed daily	Dumpsters at the Base

Notes:
CFR = Code of Federal Regulations
DOT = Department of Transportation

The following subsections address specific control and management practices for low-level radioactive waste (LLRW) and non-LLRW. Waste determined to be non-LLRW will be transported and disposed of by Gilbane. LLRW will be transferred to the Navy's LLRW contractor, and disposed of off-site, in accordance with the MOU.

7.2 Radiological Waste Management

Waste materials deemed to be LLRW will be managed in accordance with the *Radiation Protection Plan* and applicable license procedures, including SOP PR-RP-170, *Radioactive Material Control* (**Appendix C**).

7.2.1 Waste Classification

Accumulated waste deemed to be radioactive waste will be classified as LLRW based on 49 CFR, basewide requirements, or disposal facility requirements. Waste characteristics, including the radionuclides present and their associated specific activities, will be measured by an available standardized test method, such as gamma spectroscopy, strontium analysis, or alpha spectrometry, in accordance with the SAP (**Appendix A**).

7.2.2 Waste Accumulation and Storage

Soil, debris, vegetation, water, and materials classified as LLRW may be generated during sampling. When classified as LLRW, these wastes may be placed in containers provided by the Navy (55-gallon drums, super sacks, or equivalent). When filled, LLRW containers will be transferred to the custody and control of the Navy's LLRW contractor, who will provide brokerage services including waste characterization sampling, transportation, and disposal in accordance with federal regulations and disposal facility requirements. Containers will be properly lined and an absorbent will be used if it is considered necessary. Containers will be radiologically surveyed when filled with material. Each container will be properly inventoried and labeled. Inventories will include material description and isotopic identification, and identification of hazardous components, if appropriate. The contents of each container will be recorded in the field logbook, and each container will be assigned a unique identification number.

Containers will be stored in a designated and posted radioactive material storage area under the authority of the Navy's LLRW contractor's radioactive material license. Storage areas may be at the site where the waste originated or another location as directed by the Navy. Containers will be secured to prevent unauthorized access to their contents. Once filled, containers will be surveyed, and surface radiation dose rate measurements will be collected.

7.2.3 Labeling and Posting of Containers Containing Radioactive Waste

Each waste container containing LLRW will be labeled. The activity contained in each waste container will be reported in pCi/g, and maximum contact radiation levels will be measured in milliroentgens per hour. Following the surveying and labeling, the waste container will be placed in a designated and posted radioactive area. The container area will be posted with a "Caution – Radioactive Material Area"signage. An inventory of contents with radionuclide and specific activity (if available) will be maintained by Gilbane until the custody of the material is transferred to the Navy's LLRW contractor.

7.2.4 Waste Accumulation Areas

Gilbane will implement, at a minimum, the following requirements for radioactive waste stored on-site within a designated radioactive materials area:

- Industry standard posting and barrier materials will be displayed with wording that includes, "Caution, Radioactive Materials Area," at each radioactive waste storage area sufficient to be seen from any approach. The signs will be legible and clearly conspicuous for outdoor and indoor locations.
- Aisle space will be maintained to allow for the unobstructed movement of personnel, fire-control equipment, spill-control equipment, and decontamination equipment to any facility operation area, in the event of an emergency, unless aisle space is not needed for any of these purposes.
- The areas will be secured to prevent unauthorized access to the material.

- The following emergency equipment will be located within or readily available to personnel during radioactive waste management activities at each accumulation area:
  - A device, such as a telephone or a handheld two-way radio, capable of summoning emergency assistance (adjacent areas with personnel who have communication devices or areas with fixed devices that personnel can access quickly are sufficient)
  - Portable fire extinguishers, fire-control equipment, spill-control equipment, and decontamination equipment

Filled containers generated during performance of work will be stored in a material storage location until the contained material can be characterized and appropriately classified. Depending on the characterization results, the material may be moved to another storage location, transported and disposed of off-site, or reused as backfill.

7.2.5 Inspection of Waste Accumulation Areas

While all waste accumulation areas will be informally inspected daily during waste generating activities, formal inspections of all container accumulation areas will be conducted and recorded at least weekly in accordance with the appropriate Radioactive Material License requirements. The PRSO or designee will conduct inspections that will be recorded in a dedicated field logbook, and a weekly inspection checklist will be completed. The container storage areas will be inspected and the containers checked to ensure:

- The containers are in good condition. If a container is not in good condition, the Navy's LLRW contractor will be informed.
- The containers remain closed and secured at all times, except when waste is added or removed.
- The container labels are visible and filled out properly.

7.2.6 Waste Transportation

In accordance with the MOU, the Navy's LLRW contractor will be responsible for transportation of the LLRW in accordance with the DOT Radioactive Material Transportation regulations of 49 CFR for off-site disposal. Gilbane may supply DOT contamination surveys and radiation measurements on the outside of the container prior to shipment. The Navy's LLRW contractor will ensure that empty containers being returned to vendors meet the release limits for equipment and materials.

LLRW transported from the site will be accompanied by a radioactive waste manifest or a Uniform Hazardous Waste Manifest, as appropriate. Preparation of the LLRW manifests is the responsibility of the Navy's LLRW contractor.

BRAC will receive a copy of the manifest. The remaining copies will be given to the transporter. The manifest will be returned to the Navy signatory official in accordance with the HPNS recordkeeping requirements.

7.2.7 Waste Disposal

The Navy's LLRW contractor is responsible for the disposal of LLRW. The Navy's LLRW contractor will coordinate closely with RASO and Gilbane to ensure proper transfer of custody of the waste and will coordinate the shipment off-site. LLRW inventories will be managed under the appropriate radioactive material license.

7.3 Non-Radiological Waste Management

7.3.1 Waste Classification

In general, wastes generated during the project will be assessed to determine proper handling and final disposition through chemical analysis, field testing, and possible generator knowledge. The exceptions are uncontaminated wastes (i.e., no contact with contaminated media or remediation chemicals) and trash.

Samples of these wastes will be collected and analyzed to determine whether the waste is a Hazardous Waste or a Non-hazardous Waste. Analysis will be based on the requirements of the off-site disposal facility and may include total petroleum hydrocarbons (typically C_4 to C_{40}), volatile organic compounds (VOCs), semi-VOCs, corrosivity (pH), or California Assessment Manual 17 total metals. Based on the results, additional waste characterization may be needed to have the waste managed at an off-site waste management facility.

The project EM will review the analytical data and characterize and classify the waste.

Samples will be collected in accordance with the general procedures in the following section and sent to a properly licensed laboratory for analyses. If the waste is placed in containers, one composite sample (and one grab sample for VOC analysis, if needed) will be collected for every 10 drums of each waste stream. If soil is staged in stockpiles or bins, a 4-to-1 composite and a grab sample for VOCs will be collected. If liquid waste is placed in a tank or container, grab samples are appropriate. Off-site waste management facilities may require specific sampling per volume of waste accumulated under their waste acceptance policy.

7.3.2 Waste Sampling Procedures

7.3.2.1 Liquids

Analytical samples for liquid wastes will be collected from the disposal container (e.g., 55-gallon drum) before disposal; one composite sample will be collected for every 10 drums. Water samples will be collected by the following procedure:

1. Collect a water sample from a drum using a bailer or dipper if the water is homogenous or use a coliwasa if the water has more than one phase.
2. Fill the sample containers for volatile analyses first. Fill the 40-milliliter vials so there is no headspace.
3. Fill the sample containers for the remaining analyses.
4. Label and package the sample containers for shipment to the laboratory.

7.3.2.2 Solids

For soil, one grab sample and one composite sample will be collected for every 10 drums.

Soil sample procedures for collecting VOC samples are as follows:

1. Retrieve a core from the selected sample location.
2. Fill the appropriate sample containers completely full, with the material from the core.

Soil sample procedures for collecting non-volatile or metals samples are as follows:

1. Collect equal spoonfuls of soil from five randomly selected points and transfer into a stainless steel bowl.
2. Use a stainless-steel spoon and quartering techniques to homogenize the five samples.
3. Fill the appropriate sample containers completely full, with the homogenized sample material.
4. Close the containers, label them, complete chain-of-custody documentation, and package them for shipment to the laboratory.

7.3.3 Waste Profile

Waste characterization information will be documented on a waste profile form provided by the off-site treatment or disposal facility and reviewed by the project EM before being submitted to the Navy. The profile will be reviewed, approved, and signed by the appropriate Navy personnel. Signed profiles will then be submitted to the designated off-site facility.

The profile typically requires the following information:

- Generator information, including name, address, contact, and phone number
- Site name, including street/mailing address
- Process generating the waste
- Source of contamination
- Historical use for the area
- Waste composition (e.g., 95 percent soil and 5 percent debris)
- Physical state of waste (e.g., solid, liquid)
- Applicable hazardous waste codes
- DOT proper shipping name.

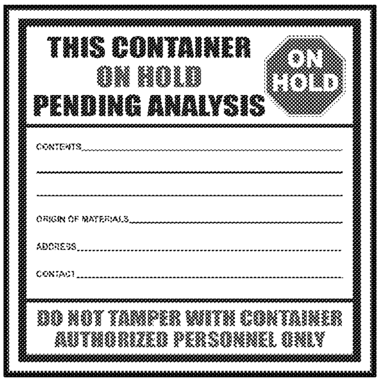
Gilbane will coordinate with its waste transport subcontractor to schedule the transportation of the waste to the off-site disposal facility after the copy of the approved waste profile is received.

7.3.4 Container Labeling

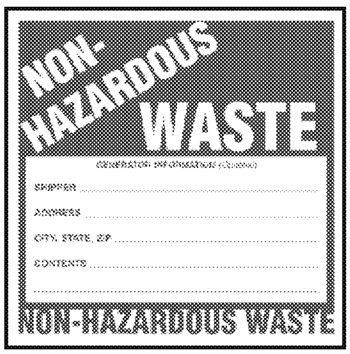
Waste containers containing contaminated media will be marked and labeled upon use concerning their contents. Each hazardous waste container will be marked in accordance with 22 CCR 66262.32. In addition, containers will be labeled and in accordance with DOT 49 CFR 172.300 (Marking) and 172.400 (Labeling), and 40 CFR Subpart C. DOT labeling is only required before transporting off-site.

The labels will note the type of waste, location from which the waste was generated, and accumulation start date. One of the following labels will be used:

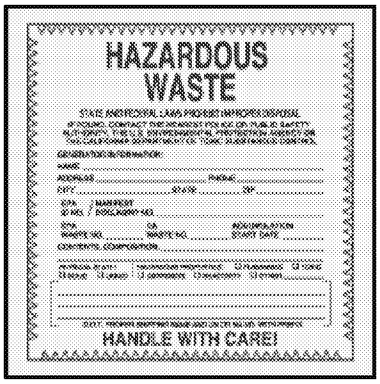
- **"Analysis Pending" or "Waste Material"**—Temporary label until analytical results are received and reviewed, and it is determined whether the waste is hazardous or not. This label will include the accumulation start date. An example is provided as follows:
  - Contents: Example – **soil from drill/auger cuttings**
  - Origin of Materials: **Former Hunters Point Naval Shipyard**
  - Address:
  - Contact Name and Phone No.:
  - Accumulation Start Date: **Please add under the Contact**



- **"Non-Hazardous Waste"**— If the waste is determined to be non-hazardous, provide the following information:
  - Shipper: **Former Hunters Point Naval Shipyard**
  - Address:
  - Contents: **Example – soil from drill/auger cuttings**
  - Contact Name and Phone No.:
  - **Please add Accumulation Start Date somewhere on the mark**



- "**Hazardous Waste:** If the waste is determined to be hazardous, provide the following information:
  - Name: **Former Hunters Point Naval Shipyard**
  - Address:
  - Phone:
  - City: **San Francisco**
  - State: **CA**
  - Zip:
  - USEPA ID No.:
  - Manifest No.: **Add before transportation**
  - USEPA Waste No.: **EM to provide**
  - CA Waste No. **EM to provide**
  - Accumulation Start Date: **The date the waste was first placed in the container**
  - Physical State: **Check solid or liquid**
  - Hazardous Properties: **Check the appropriate hazard**
  - DOT proper shipping name: **EM to provide**



If additional assistance is needed in selecting the appropriate markings and labels, the project EM or waste expert will be contacted.

7.3.5 Waste Accumulation Areas

Although hazardous waste is not expected, Gilbane will coordinate with the Navy to determine an appropriate site location to store any hazardous waste that is generated.

All containers will be physically handled in accordance with the APP/SSHP. Additional management requirements for the containers expected to be put into use can be found in **Table 7-2**.

Table 7-2: Non-LLRW Accumulation Requirements

Accumulating In:	Requirements
Drums/Small Containers	• Inspected upon arrival on-site for signs of contamination or deterioration. Any container arriving with contents or in poor condition will be rejected. • No penetrating dents that could affect the integrity of the drum are allowed. Special attention will be paid to dents at the drum seams. • Closed head drums: Will be inspected to verify that the bung will close properly. • Open head drums: Drum lids will be inspected to verify that the gasket is in good shape and that the lid will seat properly on the drum. • Arranged in rows of no more than 2 drums with at least 3 feet between rows.

Table 7-2: Non-LLRW Accumulation Requirements

Accumulating In:	Requirements
	• Each container will be provided with its own marking and label, and the markings and labels must be visible. • Drums will remain completely closed with all lids, covers, bolts, and locking mechanisms engaged, as though ready for immediate transport, except when waste is removed from or added to the drum. • Drums and small containers of hazardous waste will be transported using proper drum-handling methods, such as transportation by forklift on wood pallets, with drums secured together. Containers will be transported in a manner that will prevent spillage or particulate loss to the environment. • Drums will be disposed of with the contents. If the contents are removed from the drums for off-site transportation and treatment or disposal, the drums will be decontaminated prior to reuse or before leaving the site. • The outsides of the drums and containers must be free of hazardous waste residues. • Ignitable or reactive wastes will be stored at least 50 feet from the property line. • Drums and containers will not be located near a stormwater inlet or stormwater conveyance. • Drums containing waste liquids, hazardous wastes, or incompatible wastes will be provided with secondary containment capable of holding the contents of the largest tank and precipitation from a 24-hour, 25-year storm. • Liquid that accumulates in a secondary containment area will be removed and placed in containers within 24 hours. Removed liquids with a sheen will be characterized and classified. • New empty drums will be marked with the word "Empty". Drums that are being reused will be marked with "Empty, last contained [previous contents]" • All containers will be tracked on the field transportation and disposal log

7.3.6 Inspection of Waste Accumulation Areas

Waste container accumulation areas will be inspected at least weekly for conditions that could result in a release of waste to the environment. Inspections will focus on conditions such as equipment malfunction, container or containment deterioration, and signs of leakage or discharge. Specifically, containers (drums and roll-offs) will be inspected for leaks, signs of corrosion, or signs of general deterioration.

Any deficiencies observed or noted during inspection will be corrected immediately. Appropriate measures may include transferring waste from a leaking container to a new container, replacing the liner or cover, or repairing the containment berm.

Inspections will be recorded in the project logbook or on an inspection form. Deficiencies and corrections will also be documented. The following items will be noted in the logbook for each inspection:

- The location of the area inspected.
- Total number of containers present.

- Date.
- Verification that all containers are labeled with the accumulation start date, contents, Base point of contact, and any relevant hazards (such as flammable and oxidizer). Labels must be visible, legible, and not faded.
- The condition of containers. Good condition for containers is defined as no severe rusting, dents, structural defects, or leaks.
- The condition of secondary containment. Good condition for containment is defined as no structural defects or leaks.
- Verification that all containers are completely closed with all bolts, lids, and locking mechanisms engaged as though ready for immediate transport.
- Verification that containers are staged in rows not more than two drums wide, with labels facing outward and 3 feet of space between rows.
- Verification that all containers are being tracked on the transportation and disposal log.
- Verification that the accumulation area is clean and free of debris.
- Verification that emergency response equipment is present if required for the waste being staged.

7.3.7 Waste Transportation

Each transportation vehicle and load of waste will be inspected before leaving the site, and the inspection will be documented in the log book. The quantities of waste leaving the site will be recorded on a transportation and disposal log. A subcontractor licensed for commercial transportation will transport non-hazardous wastes. If the wastes are hazardous, the transporter will have a USEPA ID number and will comply with transportation requirements outlined in 49 CFR 171-179 (DOT) and 40 CFR 263.11 and 263.31 (Hazardous Waste Transportation).

The transporter will observe the following practices when hauling and transporting wastes off-site:

- Minimize impacts to general public traffic.
- Clean up waste spilled in transit.
- Line and cover trucks and trailers used for hauling contaminated waste to prevent releases and contamination.
- Decontaminate vehicles before reuse.

In accordance with the MOU, the Navy's LLRW contractor will be responsible for transportation of the LLRW in accordance with the DOT Radioactive Material Transportation regulations of 49 CFR for off-site disposal. Gilbane may supply DOT contamination surveys and radiation measurements on the outside of the container prior to shipment. The Navy's LLRW contractor will ensure that empty containers being returned to vendors meet the release limits for equipment and materials.

Off-site transportation and disposal of hazardous or solid wastes will be handled by the selected waste contractor. All hazardous waste transported from the site will be accompanied by a Uniform Hazardous Waste Manifest and solid (non-hazardous) waste will be accompanied by a Non-Hazardous Waste Manifest or Bill of Lading, as appropriate. Navy personnel will be responsible for reviewing and signing all waste documentation, including waste profiles, manifests, and land disposal restriction notifications (manifest packages). Before signing the manifest, the designated Navy official will ensure that pre-transport requirements of packaging, labeling, marking, and placarding according to 40 CFR Parts 262.30–262.33, and 49 CFR Parts 100–178 are met.

7.3.8 Waste Disposal

Hazardous and solid wastes will be transported off-site for appropriate treatment and disposal.

Hazardous waste will be disposed of or managed only at a hazardous waste disposal facility pre-qualified by Gilbane and permitted for the disposal of the particular type of hazardous or solid waste generated.

7.4 Waste Minimization

To minimize the volume of hazardous and radioactive waste generated during the project, the following general guidelines will be followed:

- Waste material will not be contaminated unnecessarily.
- Work will be planned to minimize the amount of waste generated.
- Material may be stored in large containers, but the smallest reasonable container will be used to transport the material to its destination.
- Cleaning and extra sampling supplies will be maintained outside any potentially contaminated area to keep them free of contamination and to minimize additional waste generation.
- Detergents or decontamination solutions will be mixed outside potentially contaminated areas.
- When decontaminating radioactively contaminated material, every effort will be made to minimize the generation of mixed waste.
- Contaminated material will not be placed with clean material.
- Wooden pallets inside an exclusion zone will be covered with plastic.
- Material and equipment will be decontaminated and reused when practicable.

- Volume reduction techniques will be used when practicable.

7.5 Compliance with CERCLA Off-site Rule

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Off-site Rule, wastes, such as contaminated soil or hazardous waste generated from remediation activities, at a CERCLA site may be transferred only to off-site facilities that have been deemed acceptable by the USEPA Regional Off-site Contact (40 CFR 300.440). With Navy approval, Gilbane will confirm with EPA's Region 9 Off-site Rule Coordinator that a disposal facility has current offsite rule approval before shipment of any wastes, and will request proof of Off-site Rule approval from the off-site disposal facility before transferring any wastes to that facility.

Other disposal practices to be followed are as follows:

- Hazardous waste (State and Resource Conservation and Recovery Act [RCRA]) will be sent to an off-site, permitted, RCRA Subtitle C treatment, storage, and disposal facility or Wastewater Treatment Facility permitted under the Clean Water Act.
- Non-hazardous wastes will be disposed of at an off-site RCRA Subtitle D facility permitted to receive such wastes. It is expected that contaminated soil and debris will be classified as non-hazardous and disposed of at a Subtitle D facility.
- Decontamination water may be discharged to an on-site water treatment facility with written permission from the Base or disposed of off-site at a facility permitted to accept the waste.
- Uncontaminated debris may be sent to municipal landfills, landfills designated for construction/demolition debris, or a recycling facility.
- General trash will be disposed of in dumpsters at the shipyard.

The designated off-site facility will be responsible for providing a copy of the fully executed waste manifest and a certificate of treatment or disposal for each load of waste received to the generator.

7.6 Documentation

Documentation requirements apply to all waste managed during project activities. Field records of all waste-generating activities will be kept. All pages of the field data record log will be signed and dated by the person entering the data. The following information will be recorded in the log:

- Description of waste-generating activities
- Location of waste generation (including depth, if applicable)
- Type and volume of waste
- Date and time of generation
- Description of any waste sampling

- Name of person recording information
- Name of field manager at time of generation

7.7 Updating the Waste Management Plan

The Waste Management Plan section will be updated as changes in site activities or conditions occur, as changes in applicable regulations occur, and as replacement pages are added to this work plan. Revisions to waste management procedures will be reviewed and approved by the Navy. All changes to the plan associated with radioactive or mixed waste will require approval from RASO.

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8.0 Environmental Protection Plan

This section briefly describes the environmental protection plan that will be implemented.

8.1 Land Resources and Vegetation

Parcel B is within a developed former industrial area with limited to no vegetation. The administrative provisions of the applicable permit programs will be applied to protect wetlands and streams, if appropriate.

8.2 Fish and Wildlife, Threatened, Endangered, and Sensitive Species

Several hundred types of plants and animals are believed to live at or near HPNS. No federally listed endangered or threatened species are believed to permanently reside at HPNS or in the vicinity (Levine-Fricke Recon, Inc. [Levine-Fricke] and PRC Environmental Management [PRC], 1997); however, San Francisco Bay is a seasonal home to migrating fish and birds.

8.3 Wetlands and Streams

Two freshwater streams, Yosemite Creek and Islais Creek, flow into San Francisco Bay adjacent to the border with HPNS. Surface water resources at the site are limited to small groundwater seeps from exposed bedrock and the surface water in adjacent San Francisco Bay. The administrative provisions of the applicable permit programs will be applied to protect wetlands and streams, if appropriate.

8.4 Stormwater, Sediment, and Erosion Control

Stormwater, sediment, and erosion control will be managed through the Stormwater Pollution Prevention Plan (SWPPP) included with this document as **Appendix D**.

8.4.1 Stormwater Pollution Prevention

Stormwater pollution prevention, otherwise known as stormwater management, includes measures that can reduce potential stormwater pollution from industrial activity pollutant sources. Stormwater management includes the following BMPs: a pollution prevention team, risk identification and assessment, preventive maintenance, good housekeeping, site security, spill prevention and response, stormwater pollution prevention, sediment and erosion prevention, inspection and monitoring, and personnel training. These BMPs help to identify and eliminate conditions and practices that could cause stormwater pollution. The SWPPP details the entire program, including the regulatory requirements and the methods used to meet these requirements.

Inspections play a large role in the prevention of releases and pollution of stormwater.

Qualified contractors and personnel will perform inspections as described in the SWPPP. These inspections will be documented and retained pursuant to the requirements of **Section 6.0**.

8.4.2 Stockpile Control

Stockpiles, although not expected, will be managed to ensure that any possible cross contamination with surrounding surfaces will be minimized to the extent possible. These measures will include:

- All excavated material will be placed on plastic to prevent contact with the surface.
- All stockpiles will be covered with a temporary cover or chemical soil stabilizer at the end of the shift or when stockpile additions or removals are complete. Stockpiles will be monitored at a minimum on a weekly basis, and daily before, during, and after storms or periods of high winds.
- BMPs (such as bio waddles, straw waddles, and erosion berms) will be used around stockpiles to prevent material migration.
- Stockpiling of known hazardous material will not be allowed. Hazardous material will be packaged as hazardous waste and stored under RCRA controls pending removal by the Navy's LLRW contractor.

8.4.3 Non-Radiological Hazardous Materials

Hazardous material will be managed in accordance with applicable permits, plans, rules and laws. The following will be required:

- Hazardous material will be labeled and stored properly.
- Hazardous waste will be placed into approved containers and stored in designated Satellite Accumulation Areas or Waste Accumulation Areas.
- Hazardous material or waste containers will be kept closed when not in use.
- Before workers open any container or package with hazardous material, the project EM will be consulted to determine whether pre-entry monitoring is required.

8.5 Air Quality and Dust Control

All intrusive activities will comply with the substantive requirements of the Bay Area Air Quality Management District Rule 40 and Regulations 6-305 and 8 pertaining to fugitive dust emissions and maintaining coverings on stockpiled materials. Fugitive emissions will be minimized to the extent possible. Subsurface soil within the HPNS is expected to be moist and not require dust suppression. Dust control measures will include:

- If visible dust is caused by intrusive methods, work will be paused and the source of the dust will be corrected by dust suppression.

- Continuous radiological air samples (general area) will be collected during any intrusive work within areas of known or potential radiological contamination or material.
- Areas with known or suspected radiological material that could become airborne from light winds (fine or powdered material) will be evaluated for a suitable stabilization method (dust control agent, fixatives, surfactants, or covering with erosion control covers).
- Area monitoring will be conducted using direct reading dust monitors and photoionization detector.
- Stationary high-volume area sampling will be implemented as appropriate.

A Dust Management and Air Monitoring Plan is included with this document as **Appendix E**. Any air permits (e.g., local air quality board) that are required for the performance of work will be detailed in the project environmental plan.

8.5.1 Radiological Air Sampling

Airborne activity monitoring (continuous or grab samples) and engineering controls may be required during work when deemed appropriate by the PRSO or the Navy. To control occupational exposures, appropriate PPE will be used, respiratory protection requirements will be determined, and monitoring and trending for airborne radioactive material will be performed as necessary. Engineering controls will be implemented if required to maintain airborne concentrations below the applicable derived air concentration (DAC) value for the ROCs (**Table 8-1**).

During work, if the airborne concentration exceeds the appropriate DAC, ongoing activities will cease and the affected location will be posted until the source of the airborne concentration is eliminated and levels are confirmed to be below the appropriate DAC. Air monitoring will be performed using the methods described in SOP PR-RP-150, *Radiological Survey and Sampling* (**Appendix C**). It is not anticipated that airborne contamination will occur.

Table 8-1: Derived Air Concentrations

Radionuclide	Radiation	DAC (µCi/mL)
^{226}Ra	Alpha (a)	3.0×10^{-10}
^{239}Pu		3.0×10^{-12}
^{90}Sr	Beta (b^{-})	8.0×10^{-9}
^{137}Cs		6.0×10^{-8}

Notes:
The most protective DACS for alpha and beta-emitting nuclides will be used as determined by the ROCs in that work area.
µCi/mL = microcurie(s) per milliliter

8.5.2 Non-Radiological Area and Personal Air Monitoring

Air monitoring for non-radiological contaminants is expected during fieldwork at HPNS. In keeping with the philosophy of "Zero Dust," engineering controls will be the primary method for eliminating dust. To verify the effectiveness of the controls, area-direct reading dust monitors (e.g., DataRAM) may be used. Area dust monitors may be deployed at select locations around the boundary of the site (environmental locations).

In addition, stationary high-volume sampling will include upwind and downwind monitoring for the ROCs, total suspended particulates, arsenic, lead, manganese, particulate matter with particles larger than 10 microns in size, and asbestos.

Monitoring data will be compared with the threshold concentration levels developed for the project site. If an analyte concentration exceeds its threshold level, the upwind and downwind results will be compared to identify whether the exceedance was caused by on-site activities. If on-site activities are found to be the cause of an exceedance, the SSHO will immediately implement corrective actions to enhance the dust control measures being implemented. These measures include, but are not limited to, applying additional water and soil stabilizers, reducing driving speeds on unpaved roads, and modifying the equipment and approach used to perform the work activities.

Breathing zone action levels will be established for non-radiological contaminants (e.g., heavy metals and polychlorinated biphenyls), based on prior soil sampling at the site and the task (e.g., drilling and excavation). Direct-reading monitoring equipment (such as DataRAM and photoionization detector) will be used to verify that action levels are not exceeded during work tasks.

Each project task plan will be evaluated if non-radiological personal integrated air sampling is required, in addition to direct-reading monitoring. The SSHP will be updated via a Field Change Request if additional monitoring is needed based on task-specific chemicals of concern. The APP and SSHP further discuss personal air monitoring requirements of the project.

8.6 Noise Prevention

Using standard OSHA occupational noise evaluation methods, the time-weighted average for any 8-hour period will not exceed 90 decibels (dBA) to any worker. In addition, Gilbane will endeavor to limit noise directly resulting from project work at or below 80 dBA at the task area boundary, or 70 dBA at the HPNS boundary. Due to concerns from local residents on and around the shipyard, heavy equipment operations generally are not permitted prior to 0700 hours nor after 1800 hours daily, and no vehicles are allowed to park or idle at the Hunters Point entrance before or after work hours. Work on Saturdays and Sundays is not expected, however if necessary will require advance approval by the Navy, ROICC, and CSO Representatives.

8.7 Construction Area Delineation

Construction area delineation will be evaluated upon arrival of the advance project personnel. Following this evaluation, minor modifications may be made to the project plans and procedures to reflect the current conditions.

8.8 Traffic Control Plan

Traffic control will be implemented in accordance with a traffic control plan that will be produced prior to mobilization, to be reviewed and accepted by the Navy RPM, ROICC, and CSO, which will account for available HPNS and Parcel access points at the time of field work initiation.

8.9 General Operations

General operations will be governed under this work plan to ensure that any operation conforms to the requirements listed within. These requirements are specific to the type of hazard (e.g., radiological, hazardous material, and health and safety) and further require that each task have a corresponding AHA. Review of the general operations AHA will include all environmental programs and permits to ensure compliance.

8.10 Spill Prevention, Response, and Reporting

The project spill plan is provided in the APP/SSHP.

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FIGURES

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TABLES

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APPENDIX A

SAMPLING AND ANALYSIS PLAN

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APPENDIX B

CONTRACTOR QUALITY CONTROL PLAN

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APPENDIX C

RADIATION PROTECTION PLAN

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APPENDIX D

STORMWATER POLLUTION PREVENTION PLAN

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APPENDIX E

DUST MANAGEMENT AND AIR MONITORING PLAN

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APPENDIX F

RESPONSES TO REGULATOR COMMENTS

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